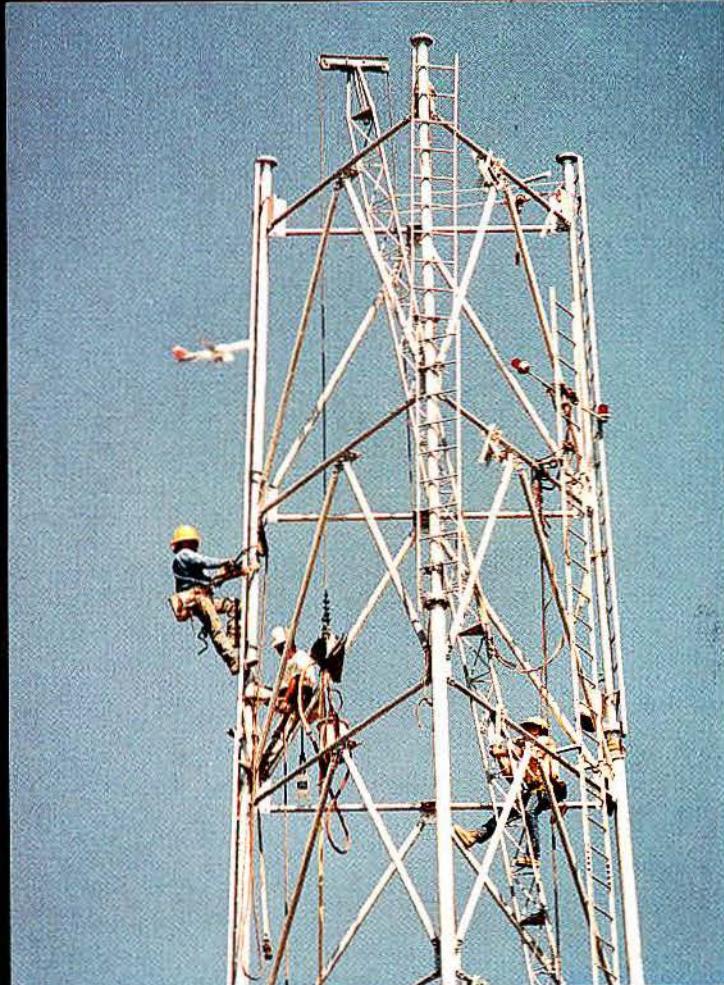
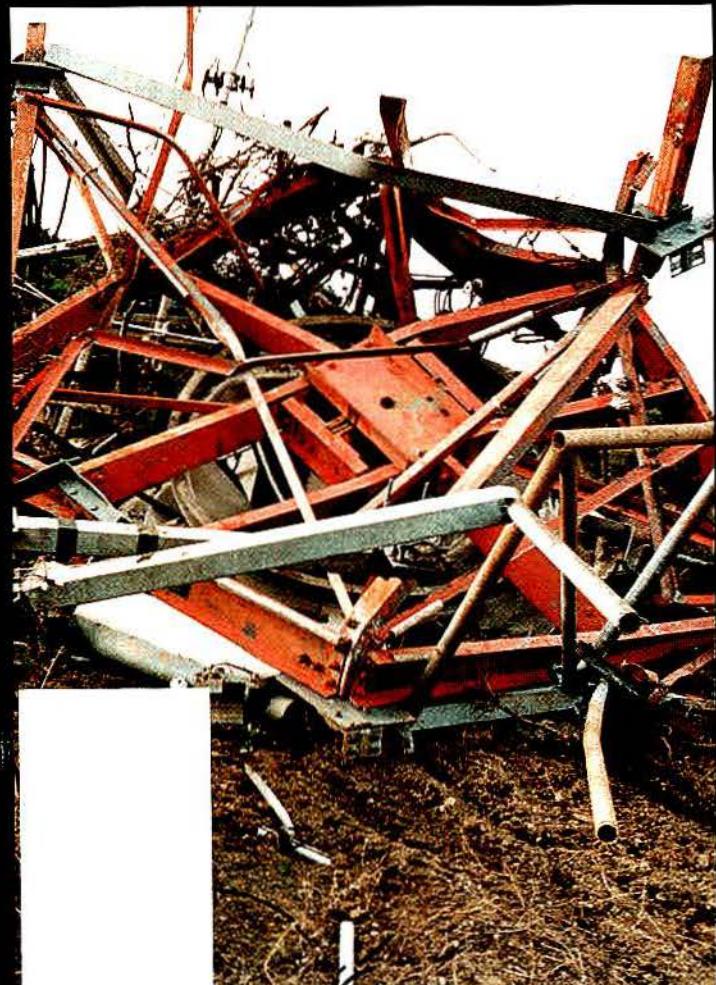


Mobile Radio Technology

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Antenna site reconstruction, p. 10

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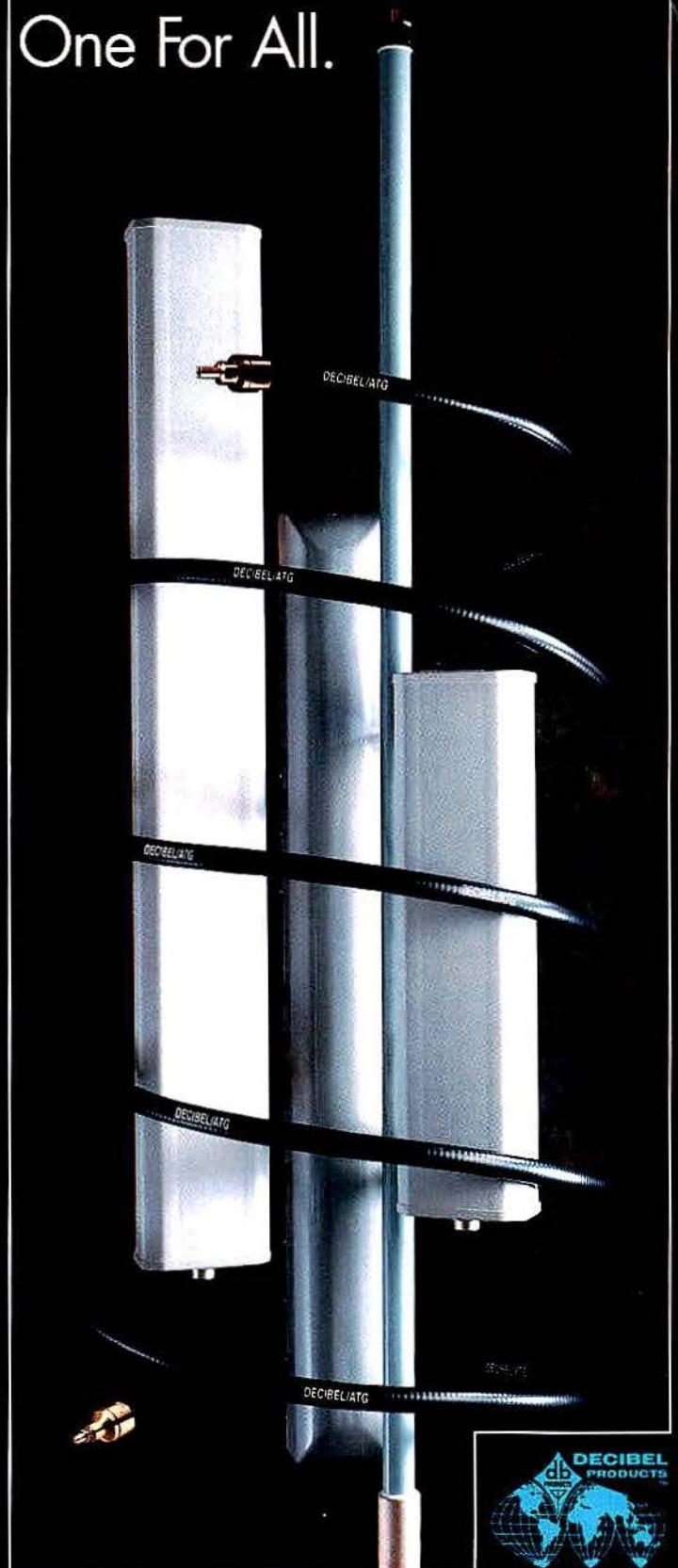
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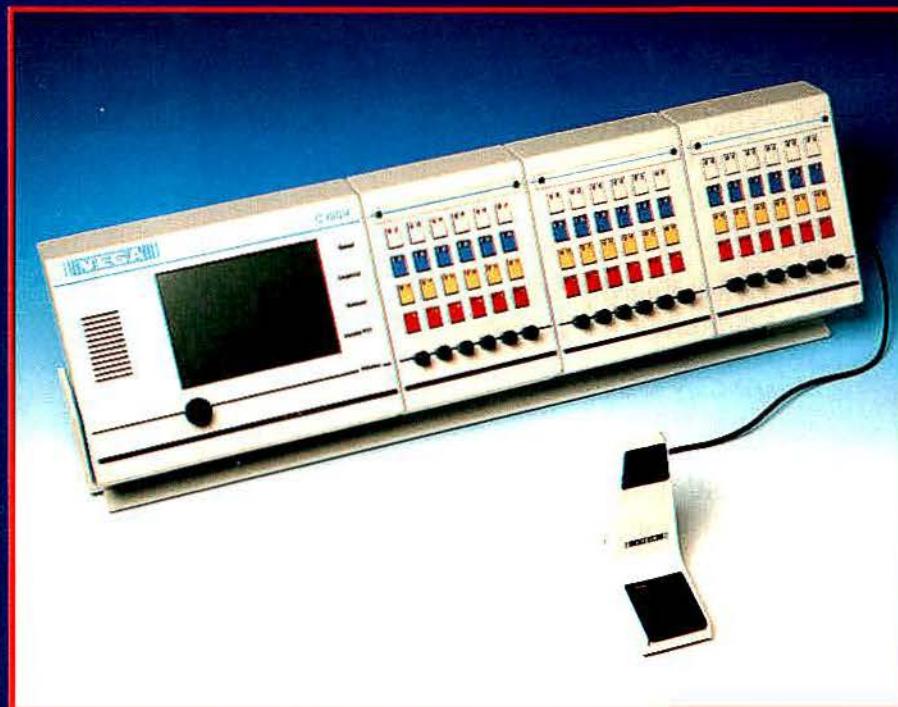
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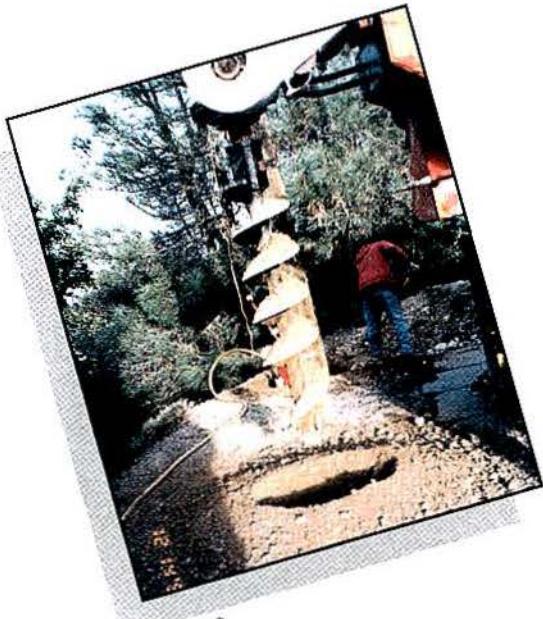
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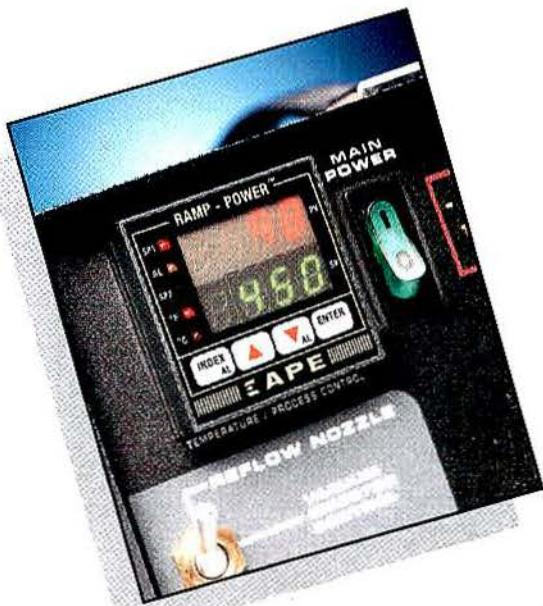
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On the cover: Scenes of destruction and rebirth. A winter storm destroyed the tower and every antenna on the mountaintop at the Mount Diablo, CA, site. Riggers assemble the new 100,000lb, tubular-leg tower. See Ron Wren's story on page 10.



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Scanning . . .



Family radio

I wonder how Corwin D. Moore Jr., the administrative coordinator of the Ann Arbor, MI-based Personal Radio Steering Group, keeps his sanity. Moore files petition after petition with the FCC in efforts to defend General Mobile Radio Service (GMRS) frequencies as a place in the spectrum for people to use two-way radio for *personal* communications. Not to be confused with personal communications *services*. In this case, personal communications means using mobile and portable two-way radios, sometimes with repeater relays, for communication with family and friends. No monthly payments to a cellular company, a paging company, a specialized mobile radio (SMR) or enhanced SMR (ESMR) company.

The FCC has released rules creating a so-called Family Radio Service (FRS) to authorize the unlicensed use of radio communications equipment on channels in between the 467MHz GMRS channels. GMRS repeater receivers are tuned to channels only 12.5kHz away from the FRS channels that will be occupied by signals 20kHz wide; hence, some unlicensed FRS transmissions are likely to interfere with licensed GMRS repeaters. Depending on how the FRS radios are used, the interference could be constant.

Under the rules, which contain few prohibitions, voice-activated FRS radios could be used as repeaters. They could be interconnected with the public switched telephone network. They could be operated by remote control, or used for the remote control of other stations or objects. They could be used as baby monitors, transmitting continuously, as a manufacturer that intends to make FRS equipment suggests. Many of these FRS uses could render GMRS systems less usable if not unusable in some instances and at some times.

Even though our magazine normally doesn't cover GMRS, Moore is kind enough to send copies of his newsletter and petitions. They're extremely well-written and documented. Apparently, with respect to FRS, they haven't been effective, although they deserve to be.

Those who rely on the land mobile radio industry for a livelihood have plenty to defend as the FCC goes about trying to dismantle business and industrial private radio services with a certain amount of success. (The government has had some-

what less success in undermining public safety private radio services.) Those who want to sell consumer telecommunications products are putting pressure on other radio services, too. What happens to your neighbor could happen to you, so it might help to watch what goes on with GMRS—and even to help out. You can write to Moore and PRSG at P.O. Box 2851, Ann Arbor, MI 48106.

* * *

Tower available

A volunteer radio group, Philadelphia Area Repeater Association (PARA), acquired several sections of triangular tower. After using what it needed, the group has two sections left over, 89 feet overall with a 6' 10" face at the base and a 4' 3" face at the top. The tower, stored on farm land 22 miles north of Philadelphia, is yours for the asking, provided you can transport it. Write to PARA for details at P.O. Box 954, Valley Forge, PA 19482-0954.

* * *

Solutions

I wonder, is it only me who finds "solutions" to be an ambiguous word? Companies that announce the offering of a "solution" may not indicate whether it is a product, a service, a system, software or something else.

I finally had to accept "wireless" after a year or so of resistance. It sometimes is a useful word, especially when a writer uses it to embrace every telecommunications method that doesn't use wired terminals. Unspecific, is what the word is. Imagine: an industry that defines itself by what it is not.

Back to solutions. A ridiculous combination is when a company says it specializes in "wireless solutions." That says nothing. Well, OK, what it says to me is that the company wants inquiries from absolutely everyone in case some of those inquiries happen to have something to do with what it sells. Kind of a shotgun approach to marketing.

Now, what should come in today's mail but an announcement that someone has been named a company's "vice president of customer solutions." Give me a year or so . . . I'll come around. I know: gripe, gripe, gripe.

—Don Bishop

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- The R-2680 with optional MPT 1327 (AH)
- The Micro RF Isolator (AF)
- All of the above (AZ)

2. What do you usually test?

- Two-way radios (JA)
- Pagers (JE)
- Trunked radios (JF)
- Cell sites (JT)
- Encrypted systems (JG)
- Cell phones (JU)

3. When do you plan to buy test equipment?

- In 1 month (HA)
- 7-12 months (HC)
- 2-6 months (HB)
- More than a year (HD)

4. Do you buy test equipment in your company or does someone else?

- I do (EA)
- Someone else _____ (EB)

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Company: _____

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7-8—**Small Business in Telecommunications**, regional meeting. Sheraton Suites Market Center, Dallas. Contact: 202-223-8728.

14-17—**Communications Marketing Conference**, sponsored by the Communications Marketing Association, San Diego Princess Resort, San Diego. Contact: Bernie Brownson, 303-371-8182.

22—**Radio Club of America**, Communications Symposium, 87th Anniversary Dinner and Awards Presentation, New York Athletic Club, New York. Contact: Gerri Hopkins, 908-842-5070.

18-19—**AMTEX**, the American Mobile Telecommunications Association's Marketing and Technology Conference and Exposition, Intercontinental Hotel, Miami. Contact: 202-331-7773.

18-20—**First International Congress on Commercial Trunked Radio**, sponsored by the International Mobile Telecommunications Association, Intercontinental Hotel, Miami. Contact: 202-331-7773.

21—**Paging Infomania**, sponsored by Motorola, Wyndham Anatole Hotel, Dallas. Contact: Georgiana Salik, 214-888-5901.

1997

March

3-5—**Wireless**, sponsored by the Cellular Telecommunications Industry Association, Moscone Convention Center, San Francisco. Contact: 202-785-0081.

23-26—**Energy Telecommunications and Electrical Association**, New Orleans Convention Center, New Orleans. Contact: 214-235-0655.

April

22-24—**International Wireless Communications Expo**, co-sponsored by *Mobile Radio Technology*, Las Vegas Sands Convention Center, Las Vegas. Contact: 800-288-8606.

May

5-7—**Vehicular Technology Conference**, sponsored by IEEE Vehicular Technology Society, Hyatt Regency at Civic Plaza, Phoenix. Contact: Wendy Rochelle, 908-562-3870; Fax 908-981-1769.

June

2-5—**Supercomm**, sponsored by USTA and TIA, New Orleans Convention Center, New Orleans. Contact: 202-326-7300.

3-5—**Canadian Wireless**, sponsored by the Canadian Wireless Telecommunications Association, Montreal. Contact: 613-233-4888.

16-20—**UTC National Conference & Exhibition**, sponsored by UTC, The Telecommunications Association, Oregon Convention Center and Red Lion Lloyd, Holiday Inn, and Travelodge Hotels, Portland, OR. Contact: 202-872-0030.

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10-14—**International Association of Public-Safety Communications Officials (APCO) National Conference**, Charlotte, NC. Contact: 904-322-2500.

September

10-12—**Personal Communications Showcase**, sponsored by the Personal Communications Industry Association, Dallas Convention Center, Dallas. Contact 800-326-8638.

November

12-16—**Communications Marketing Conference**, sponsored by the Communications Marketing Association, Holiday Inn International Drive Resort, Orlando, FL. Contact: Bernie Brownson, 303-371-8182.

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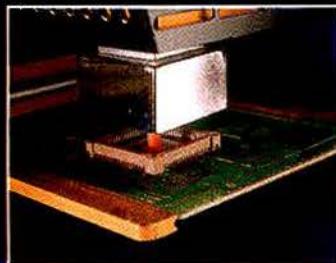


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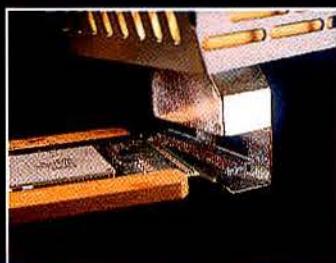


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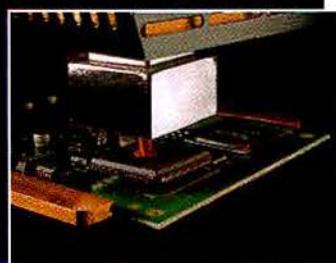
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Troubleshooting 101: Part III

By Harold Kinley, C.E.T.

The ability to troubleshoot electronic circuitry effectively and efficiently is composed of three things: knowledge, experience and an innate ability. The reference to an *innate* ability may sound unscientific and even ludicrous, but ask the old veteran service-shop managers who have "been through" many technicians over the years, and they will tell you that there is something besides knowledge and experience that goes into making the expert troubleshooter. It is intangible, but it marks the true troubleshooter!

Notice that I haven't mentioned test equipment? Test equipment is essential to troubleshooting complex electronic equipment, but it does not a troubleshooter make. Give your worst troubleshooter the best equipment and your best troubleshooter the worst equipment, and who do you think will get the job done? This is not to say that good test equipment is not necessary for good troubleshooters. It has to do with efficiency and doing the best possible job. Good test equipment in the hands of a good troubleshooter will yield the best possible results in the shortest possible time.

Resources

When troubleshooting a piece of equipment, use all the resources that may be at your disposal. This is not limited to test equipment. Don't overlook technical acquaintances or associate technicians who might have successfully dealt with the same problem in the past. Human resources are usually the best resources.

If you have another piece of equipment identical to the equipment you are troubleshooting, use it as a reference in analyzing test and measurement procedures you are performing on the ailing equipment. This expedites repairs and avoids a wild goose chase!

Keep notes on unusual problems and their solutions for future reference. Share them with your fellow technicians. Not only will they think you are a swell per-

son, they might even buy your lunch! As we get older, the notes are even more important. Ever run across a strange problem and get a feeling of *déjà vu*? Yep—been there—done that—just can't remember the solution, only the problem! Now, you have to reinvent the wheel. If *only* you had made a note—or kept the note you did make where you could find it! Oh well, "next time," will you say?

Other resources are the troubleshooting flow charts that are commonly found in service manuals. These insult your intelligence, you say? Well, I used to think the same way until I really put one of these charts to the test on an occasion. Some of

often the best place to start. This gives you a quick and logical overview of how all the individual circuit boards or subsystems are integrated to form the complete system.

More troubleshooting techniques

There are many different troubleshooting techniques. Basically, they can be reduced to a few when generalized as *voltage-resistance-current measurements*, *waveform checks*, *signal injection* or *signal tracing*. Actually, signal tracing and signal injection are about the same—one is simply the complement of the other.

Technically speaking, signal injection and signal tracing must be used together, since there must be a signal injected somewhere to be traced, and vice versa.

When testing mobile radio receivers on the bench, be sure to check the operation of the transceiver over a voltage range of 11V–15V. Even higher (or lower) voltages may occur in mobile installations, but the transceiver cannot be expected to operate properly at extremely high ends of the voltage range. Certain problems in particular transceiver models tend to show up on a predictable basis at high or low supply voltages.

One case history in particular comes to mind. A firefighter complained that his transceiver (installed in a diesel crawler tractor) started "howling" while in use on a fire suppression

incident.

To gain more insight into the nature of the trouble, I carefully quizzed the firefighter. I learned that the volume control setting had no effect on the "howling," which would begin after the tractor

(continued on page 52)

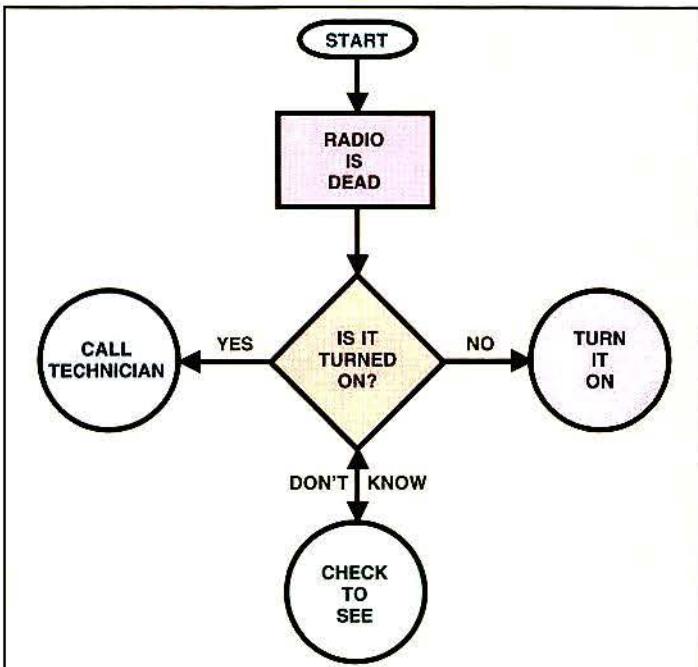


Figure 1. Some service manual troubleshooting flow charts like this one may seem to insult your intelligence, but good charts can be a valuable resource.

these charts really work, given the chance. Granted, some are much better than others. An example of a *bad* flow chart is shown in Figure 1 above. This is a deliberate exaggeration, but not too far from some I have seen!

When all else fails, *study the manual!* You may have to do some in-depth reading and hard concentration. The solution to your problem may not appear in the manual in so many words, but often something in the text will trigger a thought process that leads you right to the trouble. Studying the manual includes studying the schematic diagram as well as the functional block diagram. In complex equipment, the functional block diagram is

Kinley, a certified electronics technician, is regional communications manager, South Carolina Forestry Commission, Spartanburg, SC. He is a member of the Radio Club of America. He is the author of *Standard Radio Communications Manual: With Instrumentation and Testing Techniques*, which is available for direct purchase. Write to 204 Tanglewyde Drive, Spartanburg, SC 29301.

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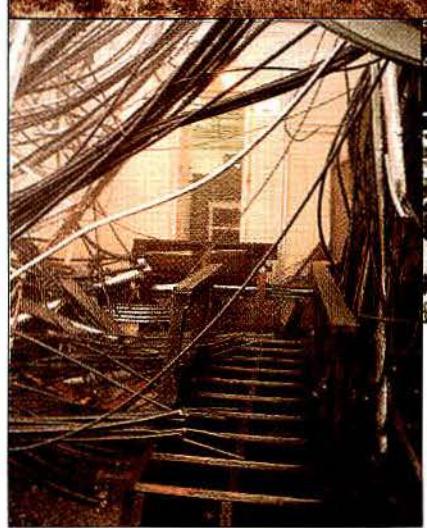
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When devil winds destroyed the Mount Diablo site

Spurred by the loss of the tower and every antenna on the mountaintop, Diablo Communications undertook the speedy construction of an unusually strong tower. Temporary facilities were on the air within days.

By Ron Wren

Driving rain and howling wind that gusted to 134mph told Jim Pedersen that no ordinary winter storm was attacking Northern California. When "MAXX," the automatic site monitoring device, reported *Alert 1*, *Alert 2* and *Alert 3*, Pedersen bounded to his Jeep and headed for the 3,849-foot top of Mt. Diablo that



Scenes of destruction awaited the first visitors to the Mt. Diablo site on Dec. 12, 1995.

overlooks the San Francisco Bay Area. "When these three alerts popped up," said Pedersen, senior site manager of Point Richmond, CA-based Diablo Communications, "it told me that the generator had started and was on line, but the automatic tower lighting system on our 280-foot, four-legged, free-standing tower wasn't working."

It was 7:36 a.m., Dec. 12, 1995. Inoperative tower lights were the least of the troubles Pedersen and many of his co-workers would face over the next 21 hours.

"My first thought was that something had come loose at the top of the tower and struck the light system, or the circuit breaker to the lighting system had tripped," revealed Pedersen. "When I checked with the office from my Jeep about 8:05 a.m., things began to look more seri-



ous. One of our clients from Bay Alarm was at the site, the office reported, and had left a message that an 'antenna had fallen off the tower.' I think the office was in 'denial' over what the client *really* said. It was too horrible to imagine!"

The office was telling him one thing; his gut was telling him something else. A

quick cell phone call to Randy Boris of Bay Alarm at the site confirmed the worst case: "It's lying on the ground, Jim."

When the site manager arrived at the mountaintop shortly after 9 a.m., he saw that "it" had indeed crashed to the ground, taking with it more than 140 antennas and the signals of scores of FM radio stations, fire, police, ambulance, paging and other systems. The tower had surrendered itself to the ravaging wind, clipping as it fell a corner of the building housing customers' radios, and landing with cables, dishes, antennas and cross-beams in a massive pile of unsalvageable debris.

Power lines to the site were intact. The power company's lines had failed somewhere in the power grid. The generator shed was undamaged, and the generator was running, but what was the condition of the equipment in the building?

Pedersen crawled on his hands and knees under the bent and crumpled tower sections through hundreds of dangling cables, up a crushed wooden staircase and into the building to discover lots of water but little damage to any of the radios. All were off the air ... but one. "To this day, I've never figured out how one FM radio station booster kept transmitting," Pedersen said, "even though the microwave dish that received the station's signal had been demolished, as well as the antenna the booster was transmitting into. It must have been random pieces of metal acting as an antenna to radiate a little scratchy signal to puzzled listeners."

Another unique set of circumstances was found in the Motorola vault inside the Diablo Communications building. A piece of the tower's climbing ladder had

Wren is the owner of Ronald R. Wren Advertising, San Francisco. Diablo Communications, founded in 1959 by the Spight family, has in operation or under construction more than 175 high- and low-level sites in California.

impaled the roof, continued into the vault and had jammed itself into the 150A service breaker panel.

The hole made by the ladder section allowed hundreds of gallons of water to pour onto 20 trunked radios and the system controller.

"To my disbelief, this broken ladder section had jammed itself into the breaker panel in such a way as to jar all 36 circuit breakers free from the breaker panel," remembered Pedersen. "Although this circuit breaker panel was still electrically energized, all the equipment was bumped off-line when the circuit breakers were 'popped' out of the breaker panel. None of the equipment in the vault was energized while water rushed over and through the electronics. What luck!"

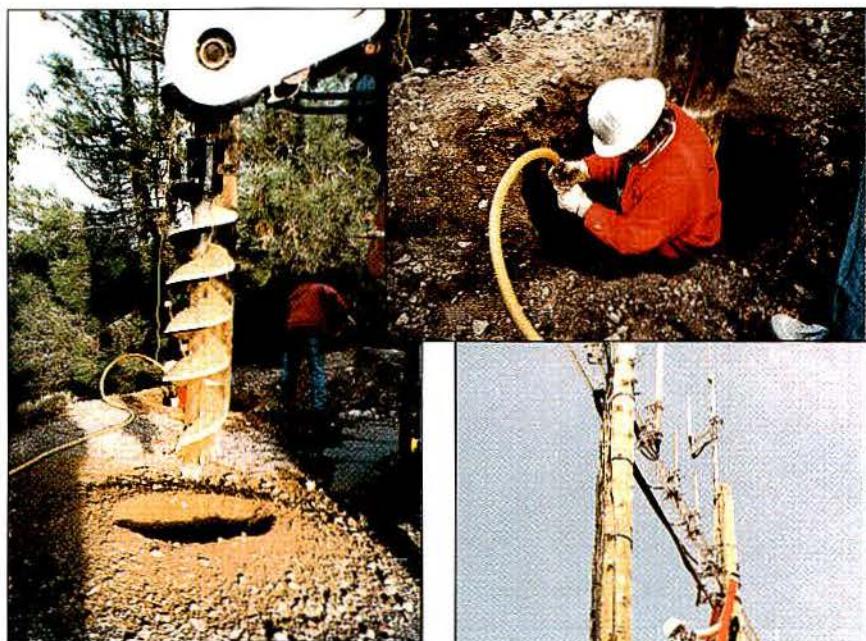
A Motorola technician later reported that, after drying out all of the equipment in the vault, only two circuit boards needed replacement.

In less than two hours after Pedersen's arrival, Michael Spight, Diablo's facilities manager, arrived with cutting tools and went to work on 200 coax cables that had to be cut and untangled from a snakepit jumble in front of the building.

Meanwhile, the company's director of operations, Paul Kammeyer, was putting together a strategic plan: a crane—once owned by Diablo and later sold to William Smedley Construction—was brought to the top of Mt. Diablo to begin another round of work for the site management company. A "snorkel" manlift was rented and trucked up the hill. Riggers from as far away as Los Angeles were hired to replace downed antennas, and Spight raced to the nearby city of Hayward to buy antennas, connectors and thousands of feet of coax from Talley Electronics.

News came in that first day about the extent of the damage around the Bay. Pacific Gas and Electric, Northern California's power company, had lost 31 steel towers and 690 utility poles. A transformer fell into a backup generator, destroying them both on a site near Vacaville, to the north. A tower on San Bruno Mountain south of San Francisco had collapsed, too.

While Pedersen inspected the building for damage, checked radios and turned off power sources, company founder Dick Spight, company president Jerry Lindquist and their team at the Point Richmond headquarters office moved swiftly to cope with the communications disaster. Clients were called and faxed to apprise them of the situation. Within hours, a contractor had been hired to torch the tower into manageable pieces to be carted away. The process consumed 36

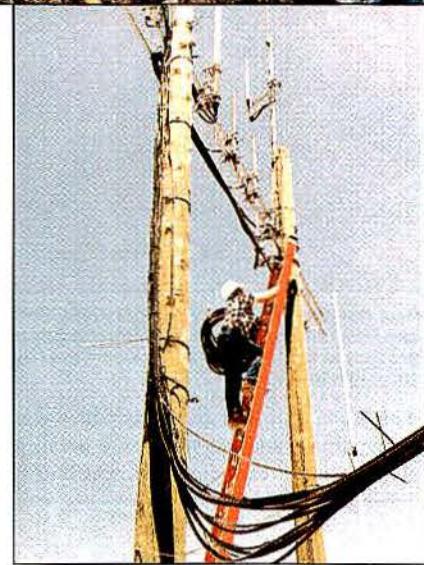


bottles of oxygen and acetylene gas. Kammeyer talked to the State of California Department of Parks and Recreation staff to discuss temporary locations for utility poles on which antennas were to be mounted. Three tower companies were called, and firm bids were requested as soon as soil test results were in. A 24-hour security service was hired for the duration of the demolition and reconstruction period.

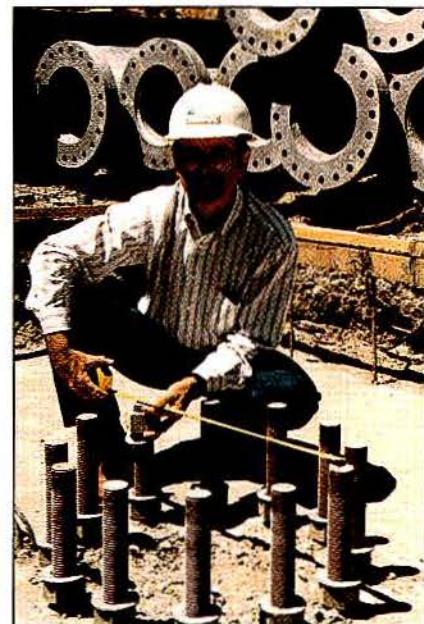
Day Two began at 7 a.m. with an executive meeting to set priorities and work schedules. Greg Brazil's Bay Communications crew was assigned to remove usable equipment and hardware from the tower. A demolition crew already was at work dismantling the tower. Before noon, Diablo's maintenance crew had brought in Rohn 25 tower sections, mounting hardware, two 40-foot cargo containers and two 150kW generators.

By 12:30 p.m., Kammeyer had met with Larry Ferri, the Mt. Diablo State Park superintendent, and an agreement was reached to use the parking lot on a ridge above the permanent site for a temporary antenna site. Ten 45-foot utility poles arrived that afternoon to be used for antenna mounting structures. Motorola shipped a 10' x 20' sea-van from Seattle, and its employees were in the process of drying out 20 rain-soaked but apparently undamaged radios. That afternoon, Diablo Communications' log recorded a mini-milestone: one 450MHz system up and operating.

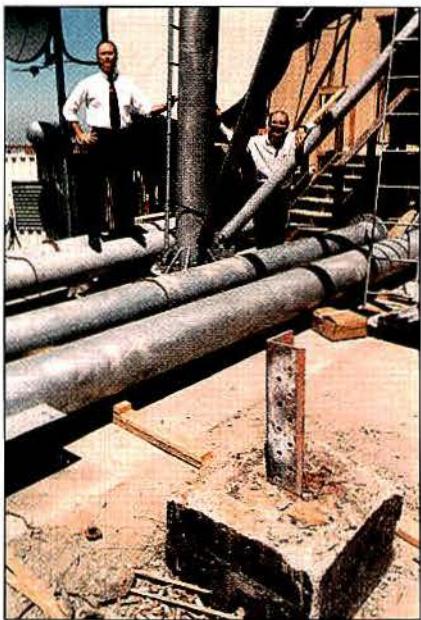
By Dec. 15, four days after the tower came down, a half-dozen steeplejacks were on recently planted poles connected



On Dec. 15, an auger drills holes, and poles are set for temporary antenna mounts. During the following days, cables are strung, and antennas are placed at the rate of eight per day.



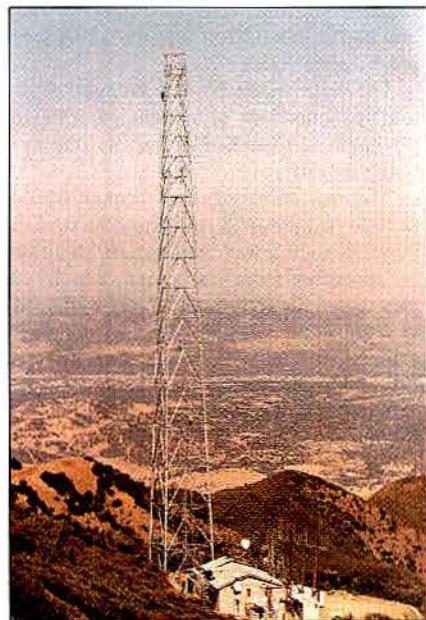
Jim Pedersen, senior site manager, checks the mounting bolts before the first leg of the new Mt. Diablo tower is put in place.



Paul Kammeyer, director of operations (left), and Pedersen compare the old tower leg (foreground) to the legs that will support the new, 100,000lb tower.



Riggers assemble the tubular-leg tower.



Nearly finished, the tower rises 300 feet above the equipment building.

with Rohn 25 tower sections, cables were being strung, and antennas were going up at the rate of eight per day. On-line by

Friday were all the 800MHz trunked systems and most of the 900MHz trunked systems.

By Sunday, all of the 450MHz systems were on-line and operating, and the majority of the 800MHz and 900MHz

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- Built in repeater maker
- DTMF selective calling/paging
- Two Transformer Hybrid for optimum null
- See standard features below

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- 2 Tone, 5/6 Tone, CTCSS Tones
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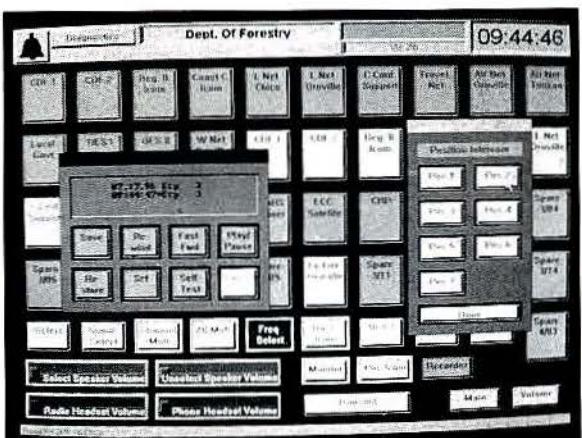
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conventional systems were on-line.

On Monday—six days after the storm—about 75% of Diablo's customers were in full operation, and by late the following day, 95% of the customers were back on-line and on the air. Among the remaining 5% were the specialty systems, such as microwave equipment that requires unique mounting configurations.

"As each of us faces minor challenges and problems over the years," said Pedersen, "we learn how to deal with each one, one at a time. That experience helps us to develop a 'what if?' plan. One day, if all of those problems hit at the same time at the same place, a good team like ours knows what to do. We take action fast. It may not be the best or final solution to the problem, but it's right for the moment."

"For all of us who have made a career in the telecommunications industry, we've had the opportunity to learn from the many experiences that collectively give us a sense of instinctive direction."

How would you or your site people prepare for a similar disaster? Some suggestions:

- Prepare a contingency plan.
- Assign key people—in advance—to each aspect of the emergency project.
- Conduct "what if?" exercises.
- Know where to turn to get temporary poles, antennas, cables and connectors. Have sources available that can supply containers, tractors, utility pole diggers and other equipment.
- Keep a list available of people who can be immediately marshaled into action as crews to dig, cut coax, install poles, mount antennas and make supply runs.
- If the site is on public land, have lines of communication in place with decision-makers such as county, state and federal officials.
- If you're a site operator, be ready to promptly advise clients of the problem, and tell them when to expect service to be restored.
- Assign someone to deal with the press.
- Revise the emergency plan as often as needed.

Diablo Communications has replaced all temporary towers with a tubular-leg tower. "It's designed to support 824,000lbs of combined weight and wind force," said Pedersen. "But some day, who knows when, Mother Nature may get angry and let us have it again. That's when we'll do what has to be done. It's called wisdom and experience."

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Simplified rework and repair of cellular telephone circuitry

These methods for removing and replacing surface-mount devices (SMD) or quad flat pack (QFP) chips from cellular circuit assemblies help service technicians to become familiar with new electronics packaging technology.

By James Dornan

Rework of cellular phone circuit boards can be simplified by controlling the process; i.e., removing or eliminating variables that might affect the outcome of removal or replacement of chip components. Usually, the goal is to remove and replace a defective chip component, in this instance a surface-mounted technology (SMT) chip or a quad flat pack (QFP) chip. This chip component is attached to the circuit card by multiple solder connections. To successfully remove the chip, it must be heated to the melting point of the solder so that all the connections or leads become molten at once. The chip then can be lifted off the card.

Motorola assisted us in developing a

commercially available hot-air rework unit, the Chipmaster, part 8100-1000, to allow economical repair of its products by independent dealers and self-maintained users. This system, quite simply, directs air heated to a specific temperature down onto the chip and its leads through a removable nozzle. Different nozzles are used for different-size chips. Air temperature is governed by a microprocessor-based controller that directly controls the air heater. The controller itself is used to create and store thermal time-and-temperature profiles for different chips for later recall and use. The operator either recalls a specific profile or enters time-and-temperature limits manually as the application requires.

For a typical QFP on a cellular phone card, however, the following procedure

for chip removal and replacement is successful time-after-time. It is designed to prevent damage to the card that can occur when heating is prolonged or carried out at an excessive temperature.

Removal procedure

Set the temperature control on the hot-air rework unit to 420°F, and set the timer to zero. To set or to change the setpoint temperature, press the INDEX key on the controller twice; then press either the UP or DOWN arrow to reach the desired temperature (shown on the red light-emitting diode [LED] display). Use the UP arrow to increase the setting. Hold the button in to make the setting increase rapidly. To increase temperature in one-degree increments, press the arrow button in individual steps. The same procedure works for the DOWN arrow button. Then press ENTER. Press the INDEX key one more time to return to the operational menu.

To reset the timer to zero, press the ENTER key and the DOWN arrow key simultaneously. The display will flash once, indicating that the timer has been reset to zero.

How the timer works

When a specific time has been set (e.g., 60 seconds), the hot-air rework unit's timer counts down to zero as soon as the foot pedal is depressed to start the heat cycle. The timer will stop at zero, even if the heating continues (foot remains on the pedal). If the timer is reset to zero, it will begin counting UP once the heat cycle begins and will STOP counting once the cycle is stopped by the operator (foot pedal released). The timer will display the cycle time (e.g., 45 seconds). Each time the foot pedal is depressed to start the



The Chipmaster hot-air rework unit allows economical repair of Motorola products by independent dealers and self-maintained users. The unit is positioned over a quad flat pack (QFP) on a circuit board held in a vise.

Dornan is international sales and marketing director at A.P.E. South, Key Largo, FL.



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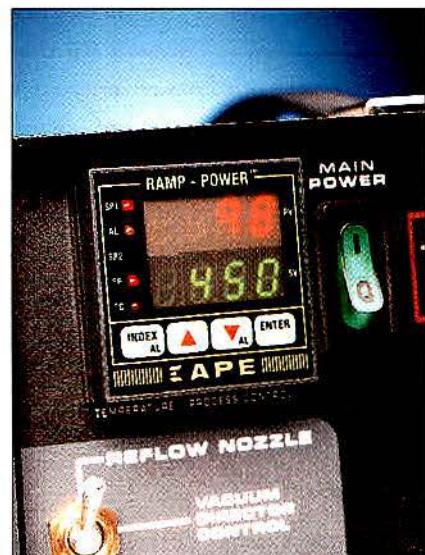
cycle thereafter, the timer will count down to zero from whatever that cycle time (in this example, 45 seconds) was recorded. The procedure for changing cycle time is similar to setting temperature.

To set time: Press the INDEX key once (from the operational menu) to reach the timer set menu. Use the UP arrow key to increase time in one-second increments; hold the button down to increase rapidly. Once the time is set, press ENTER; then

press the INDEX key *twice* to return to the operational menu.

Install the appropriate nozzle in the hot-air rework unit, either 1" x 1" or 1/2" square (vented). Center the chip under the nozzle. Depress the foot pedal to start the heating cycle. Note that the green display will begin "counting" the seconds while heating. The red display will indicate the heated air temperature as it ramps.

Turn on the vacuum pump, then depress



According to the removal procedure, settings on the hot-air rework unit control panel are manipulated to lift a chip from a circuit board once all of the solder connections have become molten, in a little over a minute.

the vacuum pickup assembly to capture the chip. The chip will lift off once all the solder connections have become molten, in a little over a minute.

When it lifts off, the chip will be drawn up into the nozzle of the hot-air rework unit. Release the foot pedal to stop the heating cycle. The green timer display will stop counting, and will indicate the length of time elapsed.

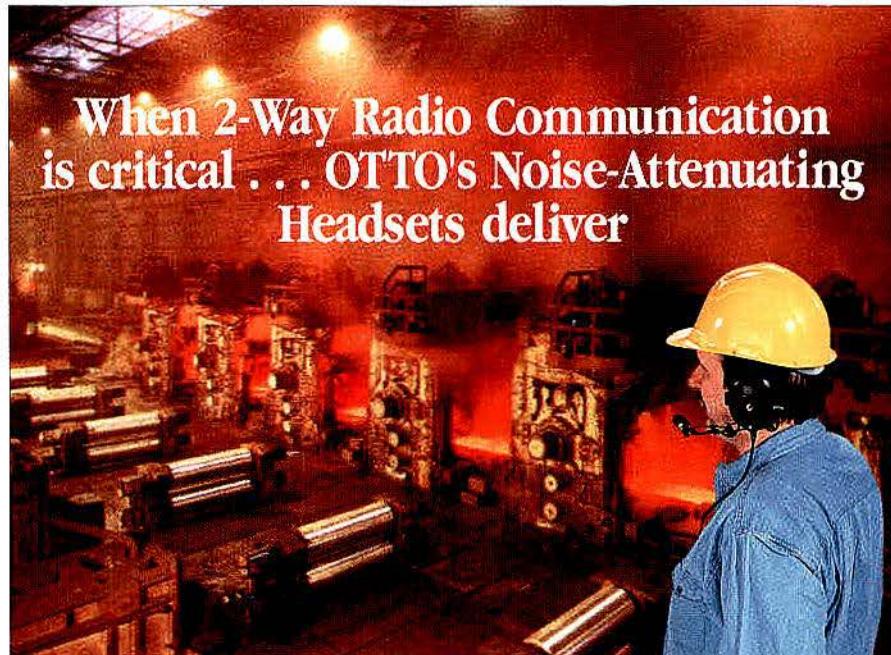
Remove the board holder arm assembly from under the nozzle.

Position a flat surface under the nozzle so that when the vacuum is turned off, the chip will drop onto the surface without damage. Turn off the vacuum pump, using the switch on the front of the hot-air rework unit. The component should release and drop onto the surface. The chip can now be laid aside.

Depress the board-holder piston (cylindrical top of the board holder); remove the entire board and holder from beneath the nozzle assembly by sliding the whole assembly sideways and out from beneath the nozzle.

Reinstallation of components

Replacement preparation. Hot-air level the pads. In most instances, sufficient solder will remain on the pads to attach a new chip, but the surface may be rough and uneven, or it may have solder "icicles," making accurate placement of a new chip impossible. To hot-air level, first place a couple of drops of wetting solution or flux on the pads. Then center the reattachment area under the heater nozzle. Depress the foot pedal to begin the heating cycle. The green display will



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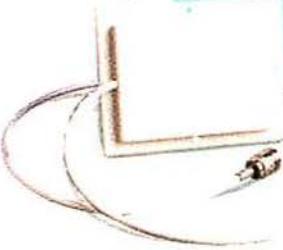
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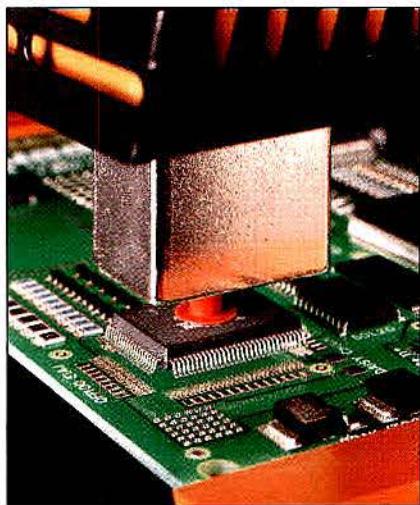
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begin counting down to zero. The solder will melt and become smooth; the solder should cover the pad(s) completely, with a slightly rounded "pillow" shape.

Remove the board and board holder assembly from beneath the hot-air rework unit nozzle (depress cylinder, slide holder and board out). Let the board cool to ambient temperature. Note: If there is insufficient solder to cover the pad(s), add solder to the pad(s) using wire solder and

a soldering iron. Apply a drop of pad prep solution to the pad(s) first, and clean afterward with pad prep cleaner. Using the white "no-clean" flux and amber needle supplied with the Motorola SMD (surface-mount device) tool kit, part 01-80303E45, dispense a small drop of flux in the center of the pad area as shown. The flux will hold the chip component in place during reflow (melting) of the solder. This flux will dissipate, however, by

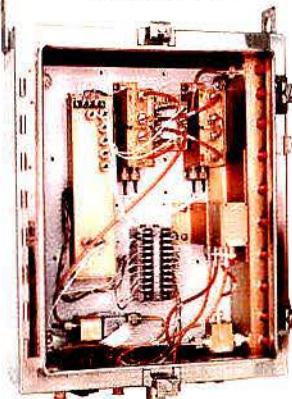


As the chip lifts off, it is drawn up into the nozzle of the hot-air rework unit. A flat surface is placed under the nozzle so that when the vacuum is turned off, the chip drops onto the surface without damage.

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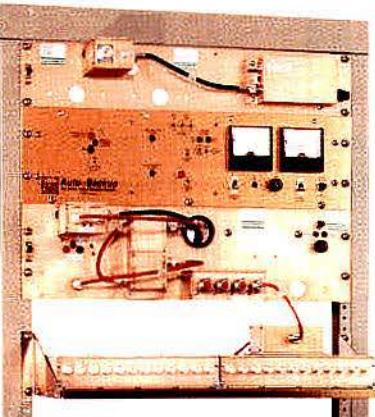


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Probes supplied in Motorola's surface-mount device tool kit assist in the chip replacement procedure to pick up a replacement chip, place it and center it on solderable pads.

the completion of the heating cycle. Pick up a replacement chip, and place and center the chip on the solderable pad(s). The probes supplied in the SMD Tool Kit can assist in this procedure.

Place the board itself under the nozzle of the hot-air rework unit, being careful to center the component under the nozzle as accurately as possible. Press the INDEX key on the controller ONCE and verify the stored time to remove the component. Add 20 seconds to the stored time by pressing the UP arrow key. This additional time will ensure full reflow. Press ENTER to save the new time, and press the INDEX key twice to return to the operational menu. The appropriate cycle time will vary, based on the size of the chip, from 1.41 to 1.2.

Depress the foot pedal to begin the heating cycle. When the timer reaches zero, the process is complete. Release the foot pedal to end the heating cycle, and, after a few seconds, remove the board from the hot-air rework unit.



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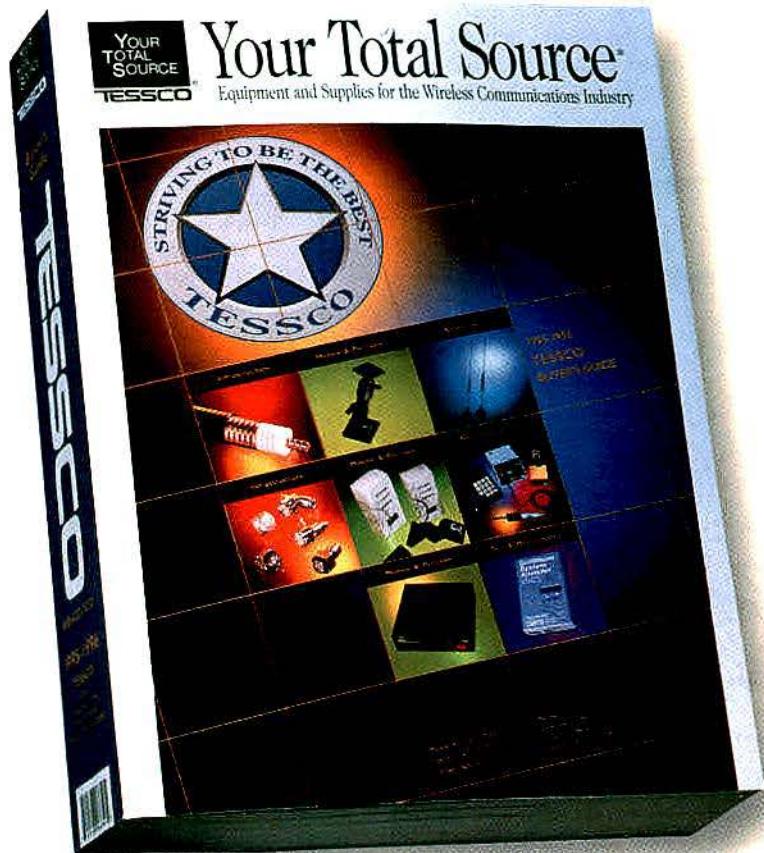
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What is normal, anyway?

Success in finding a problem sometimes depends on establishing whether a piece of equipment is working properly in the first place. Keep specifications in mind when considering possible faults.

By Walter Rheingans

Mail call is special each month when the magazine cycle arrives. Everyone in the shop has a favorite way of handling magazines, trade journals and information newsletters. Jerry takes them home and devours them; I think he reads every word in every publication. Karen has a system. First she reads the index and marks the articles that interest her. Then, whenever she has some available time, she reads some of the selected material. Ruben glances end to end, and, as time permits, tries to hit the important features. The publications have much to offer about the always-changing radio industry. Ruben says what he looks forward to most is the advertisements.

"Have you seen the antenna products this month?" Ruben asks. "I think we would be lost without the advertisements. Check out the new style, heavy-duty yagi for control stations. Let's keep them in mind. The design with an epoxy coating looks to me as though it'll stand up to the salt air along the coast and keep our customers happy."

"Yes," I reply, "keep them in mind for the next installs that we do. It'll be great if you've found a solution to the corrosion problem we have with antennas near the ocean."

I have a three-step process for the monthly flood of information. Upon the arrival of the magazines and trade publications, I immediately throw them all into a large box. When I have a little spare time, I run through the magazines, quickly noting everything and pulling out the articles and advertisements that interest me in more depth, tearing them right out of the magazine. Then, going back during quiet times, I study those saved stories. If

the story involves a major trend in the industry, we usually circulate it around the shop, and everyone discusses it.

"Did you get any calls last night, Ruben," I asked.

"Yeah, a couple of them," he replied, "but one was a real quizzer."

"What, and who, was the quizzer?"

"Bill, over at the Flood Control District office, called to mention a problem. It seems since we sold him the new signal-

with the batteries going dead over long weekends. There's nothing but an on-call crew at that time and the rest of the fleet is parked with the radios turned off. Normally, as Bill put it, there's usually only one or so dead batteries, but after three-day holiday weekends he finds most of them dead. That's what Bill called about."

"Did the FCD follow up on the vehicle battery problem?" I asked.

"Yes, they consulted with the vehicle dealer garage," replied Ruben. "The garage ran a bunch of tests on the batteries and chargers and then did a load-isolation test. That's what led to Bill's call."

"How so?" I asked.

"The garage told Bill that the problem was bum radio installations," Ruben said. "They said to Bill, 'Your radio and signaling installation is pulling down the battery, and there is nothing wrong with our trucks,' to quote it second-hand. They said that even with everything turned off, our installation was drawing a few tenths of an amp. If the battery isn't up full, that is enough to kill it over a long holiday."

"Is Bill bringing one in today?" I asked.

"Be here any moment," Ruben replied.

On schedule, Bill arrived with one of the pickup trucks from the Flood Control District fleet. The fleet consists of compact-size trucks with compact mountings, compact battery and everything that goes with small. The install is a neat dash-mount radio with an outboard decoder for DTMF, horn relay and transponder connections. The radio is an Ericsson General Electric Phoenix that the District had been using for several years. The Phoenix, an early design, is a programmable, synthesized unit that has served well and will probably continue to do so for a couple of years in the District fleet. Jerry did the signaling install, and it was a job



ing system he has good news and bad news."

"What's the good news?" I asked.

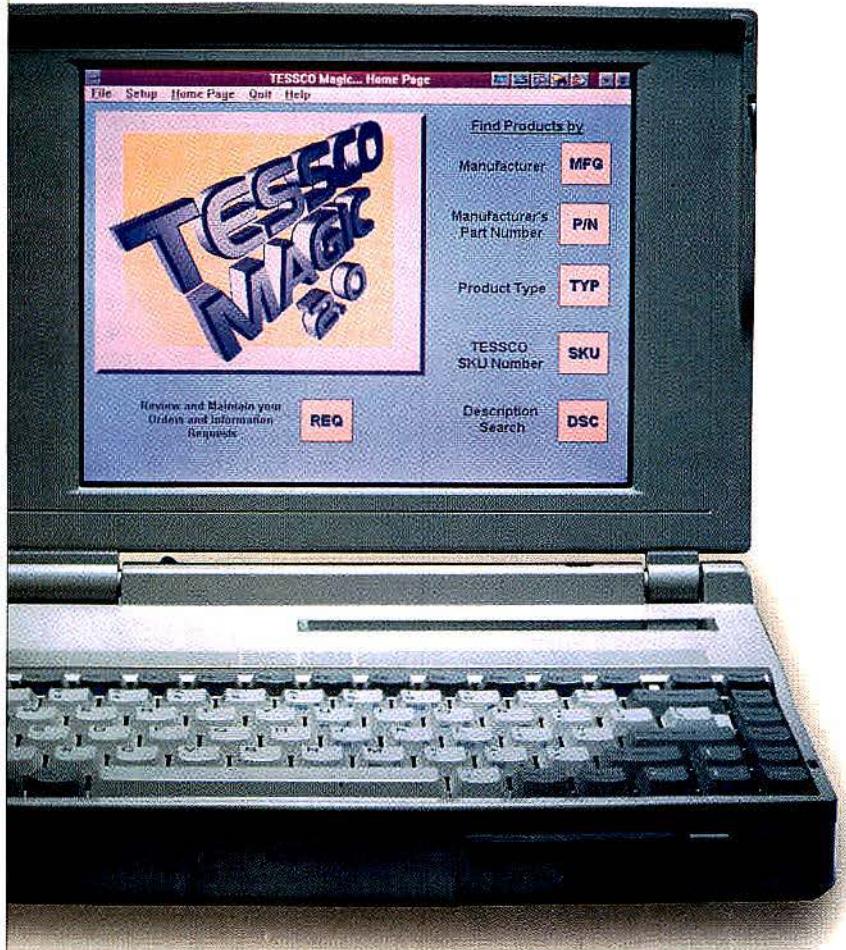
"Good news is that they love the new signaling system with the horn-honk. Bill wonders why they put off getting it for so long."

"Yeah, we had been trying to sell them on DTMF signaling for several years, hadn't we?" I replied. "Finally, the demonstration of the signaling over the shop radio setup in our service truck that Karen gave to Bill did the deal, didn't it?"

"True, true, but then there is the bad news," continued Ruben. "With the new install, the FCD keeps getting in trouble

Rheingans is a free-lance writer in San Luis Obispo, CA.

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[148]

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"Here ya go, Ruben," Bill said. "Let us know what you find. I don't think there is anything to it, but the garage says it is your radio that is broken. They said it doesn't go off even when you switch it off, and that is causing my battery problem."

"We'll get to the bottom of it, Bill."

For the next few minutes, Ruben and Jerry reviewed the drawings and notes for

this system. The decoder was an SSC unit and was wired for transponder answer back through the microphone input of the radio. The Phoenix mic plug and jack is little more than a modified edge connector, so Jerry had to set up a modification by constructing a jack-plug interface that would accommodate the signaling system. EGE sold an interface when the radios were new, but the interface used what they called a Winchester plug, and that plug

didn't really fit anything and was a real pistol to match. It cost a bunch too. Jerry's adapter was straightforward, picking up the receive audio and transmit connections and neatly bringing them to a pigtail with a Molex connector.

"The modification is really just picking up the same connections that EGE does on the factory option," Jerry said to Ruben, "and it works real well."

"I agree, Jer, but look at the current meter. I disconnected the battery wire for the vehicle, the radio is off and the cur-

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rent is just like the garage said. Now, switch the meter to the radio's fuse lead and let's measure the current again."

"Gotcha."

"Still the same!"

"The radio is off, isn't it?" asked Jerry.

"Yeah; let's check the book," replied Ruben as he went to the file for a Phoenix book.

Ruben went directly to the specification sheet in the instruction book for this UHF 16-channel radio. It only took a minute to verify the situation.

"We're being sandbagged by the facts!" Ruben hollered. "The radio is supposed to draw this much when it is off. We can't fix it if it ain't broke. It is normal!"

"Yeah," added Jerry, "but then why does the battery go dead? The Flood District has been using these radios for four or five years now, and there has been no problem with dead batteries. Why now?"

"You guys are forgetting the obvious," interjected Karen from her repair bench. She had taken in this whole conversation while catching up on her repairs. "From where I sit, and this is a real high stool, it appears to me that you aren't considering the fact that Jerry has modified their whole installation when he installed the signaling. What did you change, Jerry?"

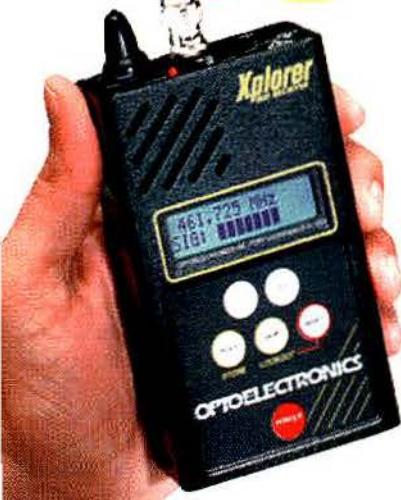
"Nothing . . . well, . . . er, actually," stammered Jerry, "nothing, but everything, if you get my drift."

"Are you claiming to be drift, again?" Karen asked.

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"Let's review the situation, you guys," Ruben said, putting a stop to the chatter. "According to your notes and design sheet, the radios were originally wired through the ignition switch, right? Then, when adding the signaling system, you wired them direct to the battery?"

"Well," defended Jerry, "almost like you said. They were wired 100% through the ignition switch originally. That is the easy way, when there is no need to use the

radio when the vehicle is off. But with the signaling, I had to change the wiring to keep the radio hot all the time. This allows the unit to be called when the worker is out of the vehicle and the vehicle is shut off."

"So here we are," said Ruben, "damned if we do and damned if we don't. How can we keep the signaling working and also not kill Bill's batteries every weekend? That's the \$64 question."

"Actually it's only about a \$50 question," said Karen.

"How's that?" asked Ruben.

"Yeah, how?" joined Jerry.

"I was reading the advertisements yesterday, and I noticed a product made just for your type of problem," stated Karen. "It seems that you are not the first to have this trouble. The wide use of synthesized radios has caused a wave of similar troubles. Most radios with programmable features and all the bells and whistles, it seems, are standby power hogs. Look at this ad."

"Yeah, I see what you mean: automatic power shut off module 'eliminates dead batteries,' claims the manufacturer," said Ruben. "This is exactly the solution. It will cure Bill's problem. I'll call Bill and explain the problem and get his authorization for the repairs, and Karen, you get on the phone and order some modules."

"OK," answered Karen. "Jer, notice that the module mounts in line near the battery. Real simple install on these pickup trucks."

"I figure about 10 minutes a vehicle, so you can estimate the job real easy for Bill," commented Jerry.

"We should have the modules on UPS tomorrow," Karen said. "Our distributor says they're in stock."

"Hey, you guys, I found another article about this problem," I said. "It seems the older radios are especially big power hogs. Most of the latest designs are becoming more trim on the milliampere diet, but when you need a full-time radio for signaling and no dead batteries, the accessory turn-off module is hard to beat. The module helps eliminate the obvious 'I forgot to turn off my radio last night' problem that always seems to happen."

"Great solution to a real problem," said Jerry.

"Good timing, too," added Ruben.

"Grand idea; wish I'd thought of it," allowed Karen.

"What I want to know," I asked, "is did you learn anything this morning?"

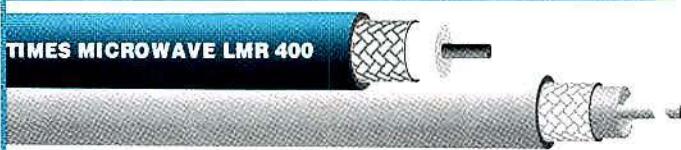
"Yeah, I learned to ask 'What is normal, anyway?' when I'm looking into a problem," Jerry answered. "If Ruben hadn't gone to the specifications sheet, I would have chased my tail all morning trying to figure out why the radio was killing the battery. The radio was normal and I had built my own trap, so to speak."

"I learned," quipped Ruben, "that we can't live without our monthly dose of trade journals, magazines, and newsletters."

"Just remember this incident, boss," added Karen, "the next time you ask 'Whatcha reading?'"

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Measuring digitally modulated RF signals

Part 2—Use a sequential-correlating channel-sounder to optimize 2GHz personal communications services (PCS) systems and to overcome the degenerative effects of multipath reflections on signals with digital modulation.

By James Bush, Ph.D.,
and Gary Schober

Reception of digitally modulated radio-frequency (RF) signals on personal communications services (PCS) frequencies can be disrupted when the transmitted signal is reflected along its path to the receiver.

In the October issue, it was explained how reflections add out-of-phase data symbols that cause bit errors and why simple signal-strength measurements with a continuous wave (CW) indicate better reception than would be expected with modulation. The following information describes measurement equipment that does a better job of analyzing PCS signals to ensure better customer satisfaction with wireless telephone call quality.

Rationale for advanced tools

Simple fading (also known as *small-scale multipath*—*multipath* is short for *multipath reflections*) of received signals is manifest as rapid fluctuations of the amplitude during brief intervals of time or across short distances. These amplitude variations often are so significant that the

natural deterioration of signal strength caused by the relative path loss from the transmitter to the receiver becomes inconsequential. Often, engineers believe that the communications link has good integrity with relatively strong signal-strength readings. Good bit-error rate (BER) performance is far more critical.

In almost all cases, short-term fading is caused by the environment, when two or more copies of the original signal arrive at the receiver at different times. These *multipath* waves, when they combine at the antenna, vary widely in both phase and amplitude. Generally, three properties affect the characteristics of transmitted RF waves that arrive at the receive antenna: *distance*, *propagation time* and *bandwidth*. For analog systems, signal strength has been the most traditional measurement of communications link quality. In an ideal environment, signal strength has a predictable relationship to distance. It has been used to determine overall coverage in analog communication system designs.

The adverse effects of multipath reception are:

1. rapid changes in the received RF amplitude.

2. some frequency modulation of the signal caused by the Doppler shifts on more than one path.

3. echoes (*time dispersion*) that cause the carriers to add or to subtract vectorially from one another, in turn causing data symbols to cancel each other.

There are three popular methods of quantifying small-scale multipath: *direct-pulse measurements*, *swept-frequency measurement* and *spread-spectrum sliding correlator measurements*.

Direct pulse measurement is the simplest way to characterize an RF channel. In practice, a rapid pulse is transmitted close to the frequency of interest, then received and demodulated, usually with an envelope detector. The minimum resolvable distance in time between paths is governed by the width of this stimulus pulse. The relative bandwidth consumed with this *channel-sounding technique* is quite wide and, consequently, noise immunity is poor because of the wide filters that must be used in the receiver. Also, the receiver's dynamic range is rather limited, so an exact capture of this asynchronously transmitted pulse is difficult because blocking (interference) or severe fading may occur. At times, the leading edge of the received energy might be below the noise, making it difficult to trigger an oscilloscope precisely at the start of the impulse waveform.

The *swept-frequency*, channel-sounding technique sweeps the channel with an RF signal in discrete steps and, through post-processing, converts this information from the frequency domain to the time domain using an inverse discrete Fourier transform. This form of

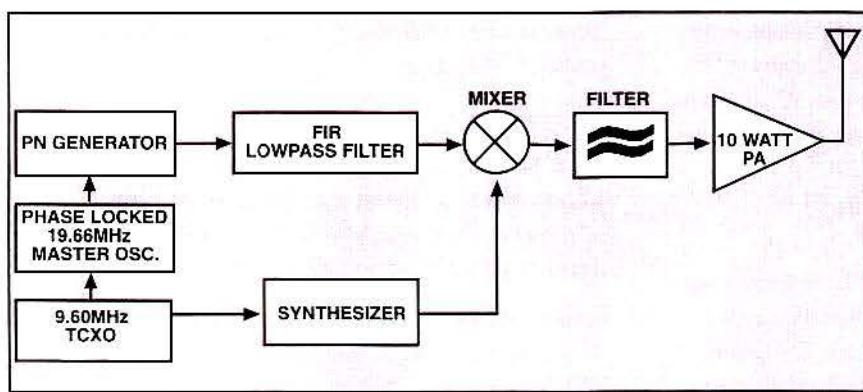


Figure 1. The functional block diagram of a sequential-correlating channel-sounder transmitter.

Schober is president of Berkeley Varitronics Systems, Metuchen, NJ. The company makes the Duet sequential-correlating channel-sounder, the sounder described in this article.



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The Berkeley Varitronics Systems Due sequential-correlating channel-sounder.

channel-sounding requires exact calibration and, unfortunately, the results are not available in real time. Moreover, the sweeping rate can affect measurement quality. To reduce the adverse effects that rapid fades have on this measurement system, fast sweeps are used. Unfortunately, the granularity of the time dispersion is reduced correspondingly. Although simple to implement, the swept-frequency form of measurement for multipath analysis has had limited success. It is most successful when it is used indoors where

the noise levels typically are much lower because of the natural shielding that buildings provide at 2GHz.

The most universal and the most sophisticated form of multipath analysis is the sliding correlator, spread-spectrum channel-sounder. For spread-spectrum applications, this approach has a secondary benefit—it mimics the type of transmission and reception hardware used in code-division, multiple-access (CDMA) telephone systems. In practice, the transmitted RF stimulus signal and the receiver used for analysis are tuned within the band to be measured, and the results are calculated and displayed in real time. Although the receiver uses filters with relatively narrow bandwidth, it has valuable processing gain; thus, the system's sensitivity is superior to analog or time-division, multiple-access (TDMA) modulation formats.

An improved version of the sliding correlator sounder is a *sequential-correlating channel-sounder*. The codes between the transmitter and receiver do not "slide" by each other. (They are not on different frequencies.) Instead, they step rapidly and synchronously from one phase alignment to another. This tech-

nique has considerably less noise because the codes cannot become misaligned during correlations. This advanced technique avoids a "smearing" of correlated data over long symbol analysis.

The sequential-correlating channel-sounder provides insight into propagation analysis in the presence of fades, noise and multipath. The instrument was designed for field use, and it permits an examination in real time and in post-processed modes the received spectrum energy, multipath reflections and bit-error rates in a way that is similar to the way the system will operate when deployed. The sequential-correlating channel-sounder system includes a 10W stimulus transmitter, a companion correlating receiver equipped with an on-board navigation system, and an 8-channel, differential GPS receiver, used to associate exact geographical position and time coordinates with the captured and stored measurements. The system includes the ability to remotely control the transmitter and receiver, permitting both forward- or reverse-link propagation studies. The receiver includes data-logging capabilities to track a selectable number of paths and to provide

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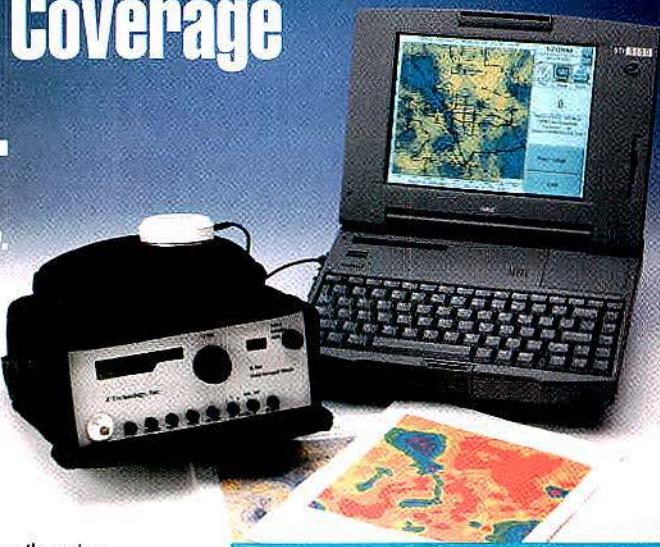
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information on the magnitude and delay of each path, BER for any path, received signal strength indication (RSSI), position and time. This tool is designed specifically to meet the requirements for practical propagation analysis for TDMA or CDMA modulation formats.

Transmitter

The sequential-correlating channel-sounder transmitter produces a user-selectable,

direct-digital-spread signal in the PCS frequency band (primarily for use with the sequential-correlating channel-sounder receiver). A functional block diagram of the transmitter system is shown in Figure 1 on page 28.

These 15-bit code generators can produce codes as long as 2^{15} and can be programmed to produce as many as 15 state linear codes. Pseudo-noise (PN) codes are a subset of all linear codes and are

most desirable for TDMA digital transmissions, including spread-spectrum and CDMA applications. The sequential-correlating channel-sounder transmitter and receiver offer the user a number of pre-defined PN codes of different lengths. Included in this selection are PN codes and chip rates that have the same bandwidth and spectral properties as Qualcomm's published in-phase (I) or quadrature (Q) pilot signals. Future versions of the software will permit sequential-correlating channel-sounders to be used for Walsh encoding, that is, for data encoding for generating unique Gold codes. The code generator's output is over-sampled to bring the sampling rate up to about 20MHz, which is a minimum of four-times over-sampling. This data stream then is fed through a 64-stage, finite impulse response (FIR) lowpass filter to eliminate out-of-band components. The FIR filter is programmable, and the user may select another filter that produces the effect of multipath to test the sequential-correlating channel-sounder receiver. The filter output drives a digital-to-analog (D/A) converter and is sent to the I/Q modulator.

The I/Q modulator produces a binary phase-shift keying (BPSK) modulated signal. This signal resembles the I and Q pilot signal for Qualcomm's CDMA as well as other formats, such as wideband CDMA (W-CDMA) IS-665. The signal then is up-converted to the PCS frequency band and is amplified to a maximum of 10W CDMA output. The output to the antenna is monitored with an internal forward and reverse voltage standing wave ratio (VSWR) detector. This detector not only monitors the amplifier-to-antenna VSWR match, it also regulates the transmitted power to maintain it at a constant level, irrespective of load or match from 1:1 to 1:6 VSWR.

The heart of the sequential-correlating channel-sounder transmitter's control logic is an Intel 80C31 microcontroller. In addition to controlling the data stream, the microcontroller interacts with the display, a telephone interface with internal modem and an optional differential Global Positioning System (GPS) receiver. The system's dual-tone, multiple-frequency (DTMF) decoder and internal modem can be used for remote control operation.

Receiver

The sequential-correlating channel-sounder receiver is a wideband (6MHz), spread-spectrum receiver that can identify and track CDMA signals and their

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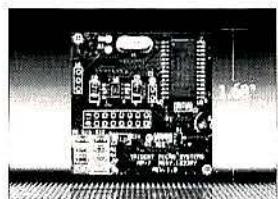
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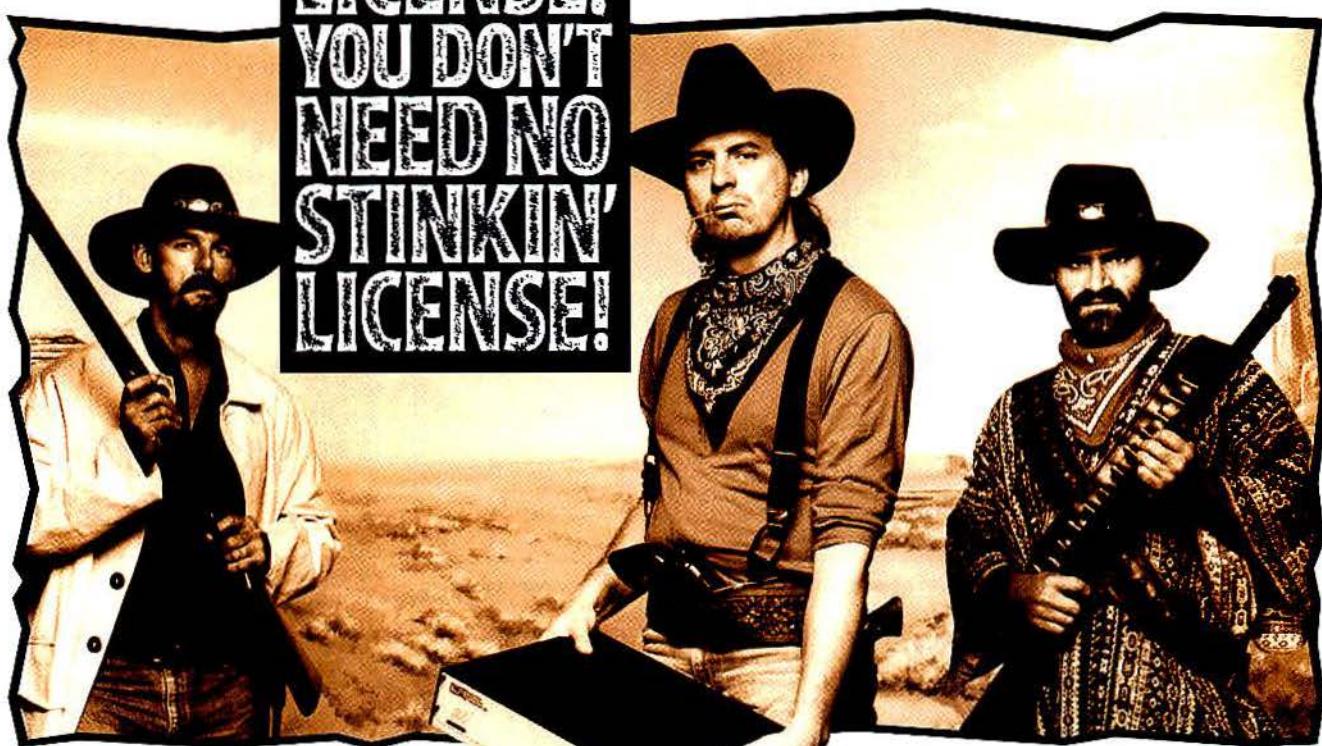


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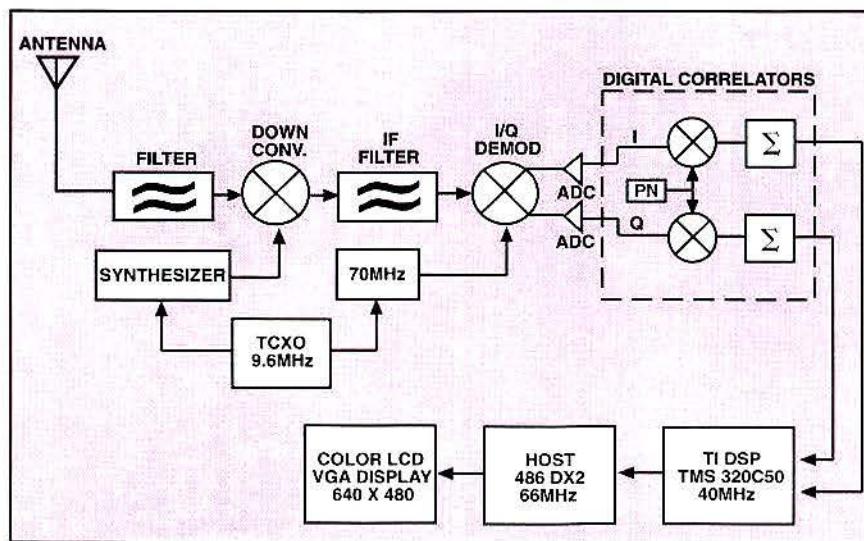


Figure 2. The functional block diagram of a sequential-correlating channel-sounder receiver.

multipath-reflection counterparts, report signal strength (in a display similar to that of a spectrum analyzer), and perform bit-error analysis for any arbitrary signal path. The functional block diagram for the receiver system is shown in Figure 2 above.

The received spread signal is down-converted to an intermediate frequency (70MHz IF). The IF amplifier and the RSSI are used as a signal strength detector with a narrow bandwidth to plot the signal strength across frequency, in a way similar to that of a spectrum analyzer, and

are used as an automatic gain control (AGC) system to maximize the receiver's dynamic range during multipath analysis. The receiver's RF sensitivity is -105dBm . When added to the processing gain of the system, the receiver's RF sensitivity exceeds -152 dBm , more than 32dB below the noise floor.

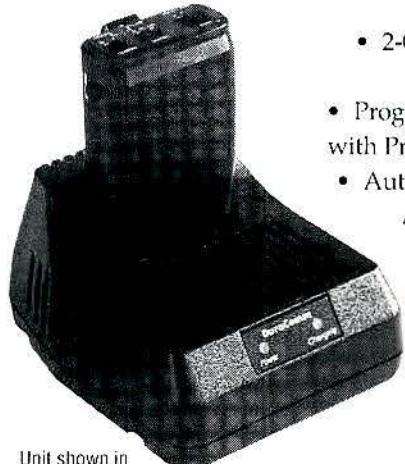
The output of the IF amplifier goes to an I/Q demodulator. The I/Q demodulator is used to receive a signal regardless of incoming RF phase. Herein is the best kept secret of this technology, a trick that is an essential part of all CDMA reception. Exactly how this trick is done is not described in any textbook or in information from Qualcomm itself. We "compute" the carrier phase (non-coherently) by digital means, using a technique learned in high school—that is, by taking the square root of the sum of the squares for both I and Q channels.

The I/Q demodulator output is sampled with a pair of A/D converters running at a sampling rate of about 20MHz. This pair of digitally sampled data streams then is fed to four independent PN correlators. The correlators are used to search for the signal and all of its

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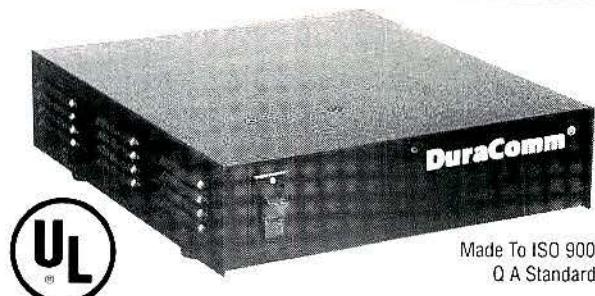
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multipath-reflection counterparts. The correlators work together with the programmable code generators. These code generators differ from the code generators in the transmitter only in that they can be made to jump instantaneously to a different code phase without stopping—a property that is required for rapid searching. Each of the power correlators can be controlled independently and can take its source from ei-

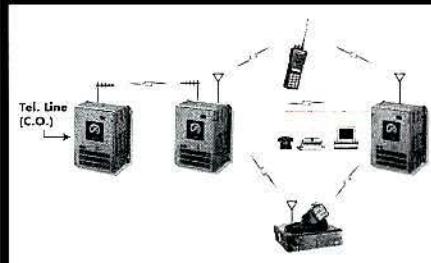
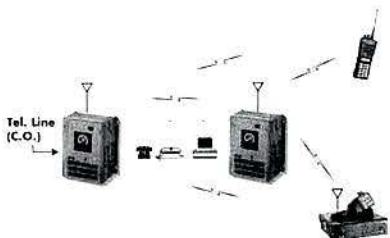
ther code generator. This capability allows one or more of the power correlators to be used as a demodulator for bit-error analysis and frees the remaining correlators to be used as high-speed delay-lock loops (DLL) to keep the demodulator locked (non-coherently) to a path. The system's internal digital signal processor (DSP) tracks any slowly drifting phase errors caused by differences in clocks between the transmitter

and receiver, and it compensates for any Doppler drifts that may occur because of motion at either end of the link.

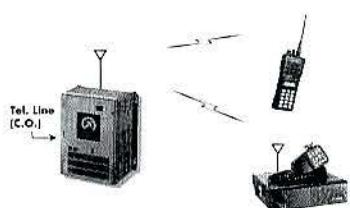
The detection hardware is directly controlled by a digital signal processor (DSP TI-TMS320C50 running at 40MHz) that performs high-speed computations and that controls the digital logic. Collected and processed data then are transferred to a 66MHz 486DX personal computer, which controls the supervisory functions of display, logging and communications. The video display is a color video graphics adapter liquid-crystal display (VGA

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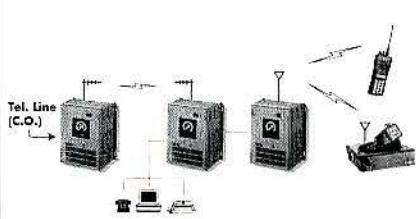


ARE

In a non-coherent communication system, a correlation is performed on the pilot to estimate the signal's RF phase so that the upright and inverted symbol phases can be determined.

LCD). Data can also be logged to a non-volatile Personal Computer Memory Card International Association (PCMCIA) memory card for post-processing. The magnitude, time dispersion (or delays, both positive and negative) of all of the received paths and the BER for any path are calculated, stored and displayed.

The BER calculation is based on how a CDMA receiver actually demodulates a symbol from a code channel. In a non-coherent communication system, a correlation is performed on the pilot to estimate the signal's RF phase so that the upright and inverted symbol phases can be determined. Symbols correlated from the code channel then are decoded with the estimated RF phase to determine whether they are correct or inverted. In the sequential-correlating channel-sounder's BER calculation, the pilot itself is considered to be a channel with constant data. A moving average of several symbols is used to estimate the RF phase of the present path. The phase of each individual symbol is compared to that of the estimate. If the symbol phase is within $\pm 90^\circ$ of the estimate, the symbol is considered to be correct. This measurement is functionally equivalent to a pre-corrected BER.



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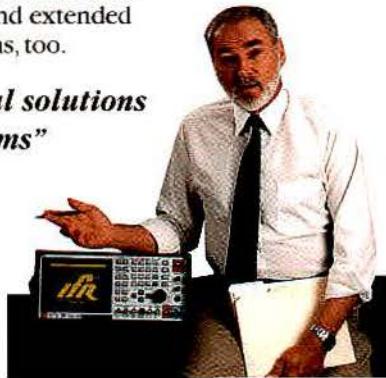
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Speeding the cell-site acquisition process

Superconducting products provide a tool to speed the site acquisition process by reducing restrictions on site selection criteria related to RF interference and coverage area.

By Marc Rolfs, P.E.

With ever-more-restrictive zoning requirements and a host of new operators vying to install thousands of new sites in every large city, tools to increase flexibility in site locations without deteriorating capacity or service quality are a welcome asset.

Wireless communication services continue to grow exponentially as the trend continues toward lower-power portable phones to replace higher-power mobiles. Consequently, spectrum congestion worsens and interference increases even as the transmit power of the remote units for the various wireless services continues to decrease.

Although these trends make it increasingly difficult for system performance engineers to keep networks operating properly, cellular customers expect a level of call quality, connection availability and connection reliability equivalent to that

Rolfs is director of sales and marketing, Illinois Superconductor, Mt. Prospect, IL.

of their primary landline telephone system. To meet these expectations and thereby maintain customer satisfaction and minimize churn among subscribers, system design engineers have had no option but to increase the number of cell sites in the service area.

Finding suitable sites is becoming more difficult. Proliferation of antennas is raising concerns among municipal boards and resident committees for aesthetic and electromagnetic field (EMF) reasons. Increasingly, the result is restrictive zoning ordinances against towers and, in many cases, against wireless antennas themselves. Using existing sites often is impractical because transmitters already in place operate at power levels sufficient to adversely affect service. Such problems are destined to worsen, not improve, as siting requirements for completely new systems, such as those for the recently auctioned PCS spectrum, are factored into the equation.

The unavoidable result in far too many cases is delay. Because the time required to design and construct a new or expanded wireless system has a direct effect on prof-

itability, delays can fall to the bottom line.

Fortunately, it is possible to speed the site acquisition process by easing the burden of locating wireless PCS and cellular systems. A new type of base station receiver front end that uses superconductor technology can reduce adjacent band interference by 30dB-50dB over conventional filters while increasing the effective receiver range by as much as 6dB. The result for service providers is significant flexibility in locating their sites while still maintaining the capacity and service quality to be competitive.

What are superconductors?

Discovered in 1911, superconductors are materials that, when cooled below a certain temperature, exhibit almost zero internal resistance to RF energy. Initially, all known superconductors were metal and required cooling nearly to *absolute zero*.

In 1986, researchers in the United States discovered a new class of ceramic superconductors that exhibits superconducting behavior at a much higher temperature than all previously known materials,

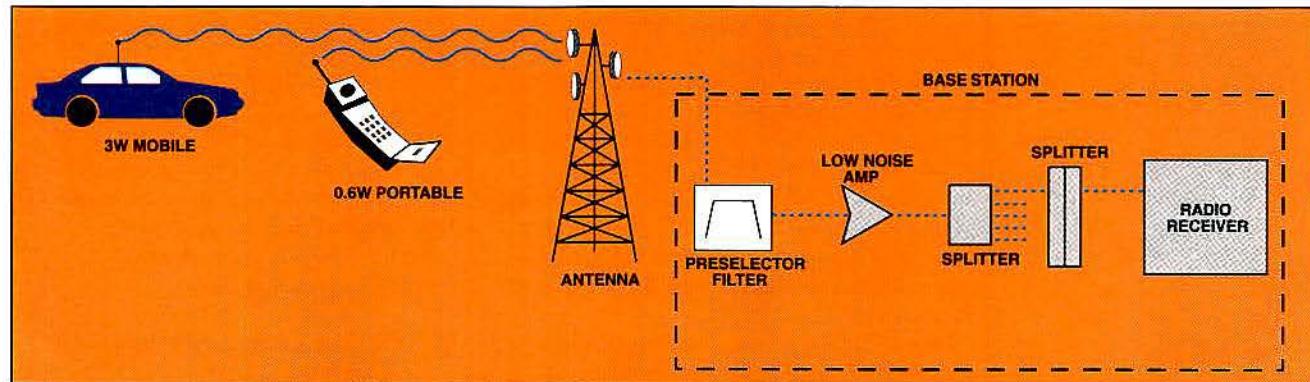


Figure 1. The preselector filter and the low-noise amplifier (LNA), the first components in the base station, compose the receiver front end. With a thin coating of ceramic superconductor material on the filter's resonator elements, RF energy passes with such little loss that an extremely high level of rejection of undesirable signals can be achieved.

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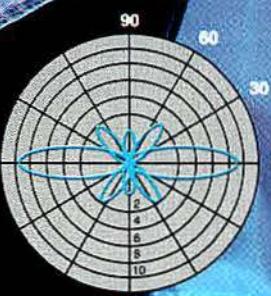
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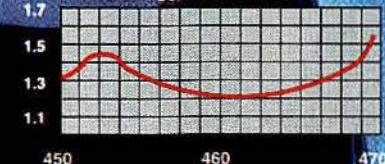
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City _____ State _____ Zip _____

Radiation Pattern (Relative Field)



Typical VSWR



Gain (Relative to 1/2 Dipole)



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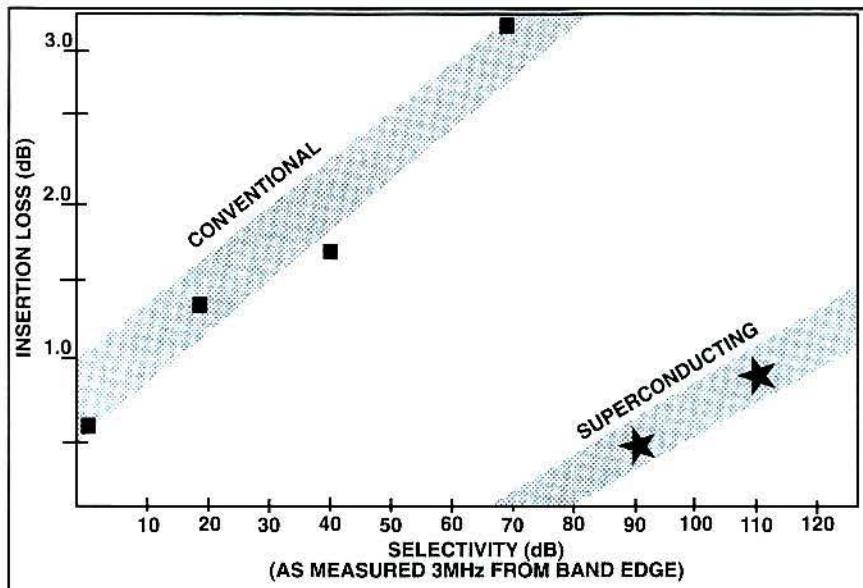


Figure 3. Insertion loss vs. selectivity for conventional and superconducting filters.

90°K (−297°F).* Although this temperature still is quite cold, reliable commer-

*K stands for Kelvin, a temperature scale with the same increments as Celsius, but which begins with 0° at absolute zero.

cial refrigeration equipment is available at reasonable cost to maintain ceramic superconductor products at their required operating temperature.

The initial commercial application of superconductor technology in the tele-

communications industry is in preselector filters for cellular and PCS base stations. As shown in Figure 1 on page 38, the preselector filter and the low-noise amplifier (LNA) are the first components in the base station. The role of the preselector filter is to reject as much adjacent-band interference as possible without worsening the desired signals significantly. The LNA boosts the desired signals so the composite signal containing numerous conversations can be split and sent to radios that can handle only one conversation at a time. Together, the filter and LNA compose the receiver front end and are specified to maximize the signal-to-noise ratio.

In response to increasing adjacent-band interference (particularly in urban environments) and the resulting deterioration of cellular system performance, base station manufacturers have upgraded their standard preselector filters to reject higher levels of interference. Unfortunately, with conventional cavity resonator filters, good rejection of adjacent-band interference can be achieved only with an increasingly high reduction in the levels of the desired signals (insertion loss). This loss is caused by the physics of filter design and by the resistive

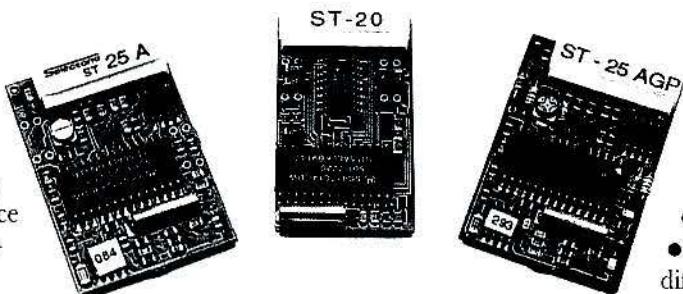
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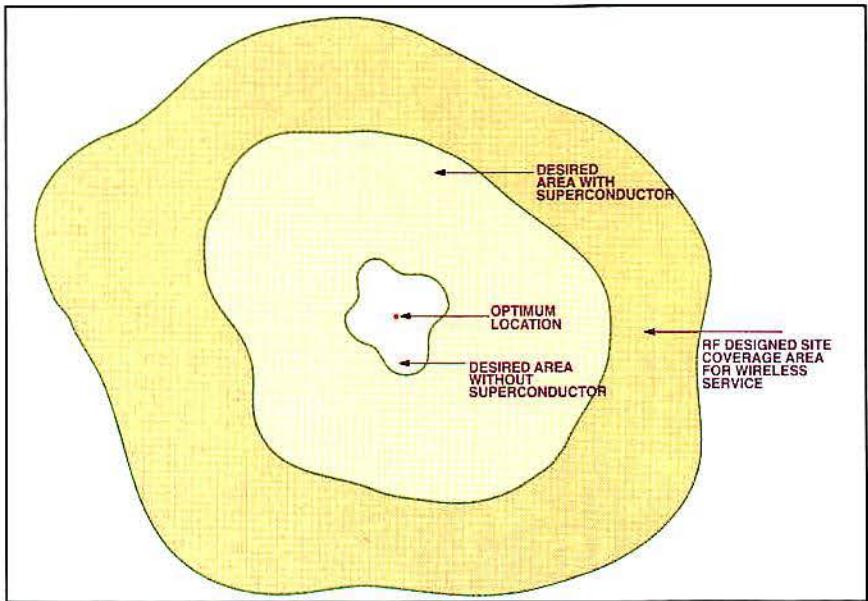


Figure 3. By using superconducting receiver front ends, cell site locations for good coverage and capacity can exist in a significantly greater area as well as being co-located at existing sites with other high-power transmitters.

losses of conventional filter material, such as copper or silver-plated copper.

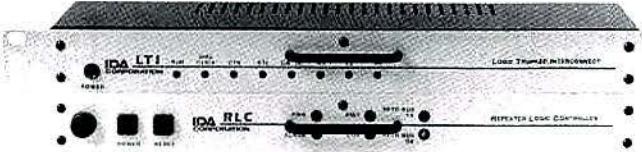
Superconductor filters eliminate this compromise between interference reduc-

tion and signal loss. With a thin coating of ceramic superconductor material on the resonator elements, RF energy passes through a filter with such little loss that

an extremely high level of rejection of undesirable signals can be achieved. With resistance at such a negligible level, the quality factor ("Q") of a superconducting filter resonator can be raised to 70,000, significantly above the 3,000 Q factor of conventional filter resonators. In practical terms, this translates into a low-loss filter with extremely steep rejection skirts at the bandpass edges and a nearly flat response across the passband. Figure 2 on page 40 shows a comparison of several conventional bandpass filters currently in use in cellular base stations with two of the first-generation superconducting filters.

Further improvement in system performance can be achieved by positioning the LNA in the cold environment. This virtually eliminates thermal noise from the LNA, which increases sensitivity of the base station to weak RF signals. Overall, compared with conventional receiver front ends, an improvement of as much as 6dB can be achieved, which translates into as much as a 50% increase in coverage area (depending on terrain, obstacles and other factors affecting RF propagation). In some cases the combined superconductor filter and LNA also improves the signal-to noise ratio, which results in enhanced voice call quality.

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Site selection flexibility

When planning or expanding a wireless system, design engineers use RF simulation tools to determine optimum coverage of a geographic area based on anticipated RF propagation, capacity and a host of other factors. The industry rule of thumb is to locate the site within one-quarter of the radius from the optimum site. If this is accomplished, the many other variables affecting coverage and performance potentially can be adjusted to provide overall good system performance. Unfortunately, the optimum site frequently is not available, and compromises must be made.

Superconducting preselector filters enhance siting flexibility in two ways. First, because they can reject as much as 30dB-50dB (1,000 to 100,000 times) more adjacent-band interference than conventional filters, they provide the opportunity for co-location on existing sites with other transmitters, with no worsening of service or call quality. Owners and municipalities often are more willing to add a new set of antennas to an existing site than to allow a completely new site to be established. Even if co-location is not necessary, superconducting preselector filters can make it possible to use a previously unacceptable site near an existing high-power transmitter.

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The expanded coverage that superconducting receiver front ends provide offers additional siting opportunities. Heavily loaded cell sites with high interference typically have a noise floor in the LNA that is attributable to intermodulation noise rather than thermal noise. Improvements in the LNA noise floor of 3dB–6dB have been measured in field trials where the decrease is fully attributable to the reduction of intermodulation noise. Fur-

ther improvements in the LNA thermal noise floor on the order of an additional 1dB at cellular frequencies can be achieved by incorporating the LNA in the preselector filter's cryogenically cooled environment. In conditions where co-channel interference is not limiting, the total gain of the receiver front end also can be increased as much as 3dB.

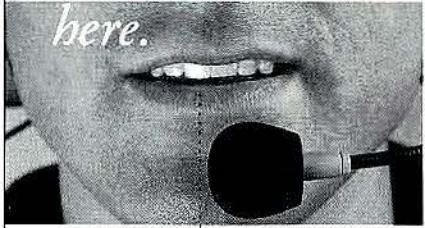
The combined effect of a superconducting low-loss filter in conjunction with a

properly designed "cold" LNA is an improvement of 6dB in effective gain in many situations, while maintaining the same signal-to-noise ratio under which the base station previously operated. In a metropolitan or suburban system environment, the effect of an improvement of this magnitude, under typical cell spacing and cellular RF propagation, can be as much as three-quarters of a cell radius. Superconducting receiver front ends thus free system designers from the constraint of the "one-quarter of the coverage radius" rule of thumb and, as shown in Figure 3 on page 42, the search for potential site locations that can provide good system performance and capacity and adequate coverage overlap with neighboring cells can be expanded greatly.

Field trial results

Numerous field trials have been con-

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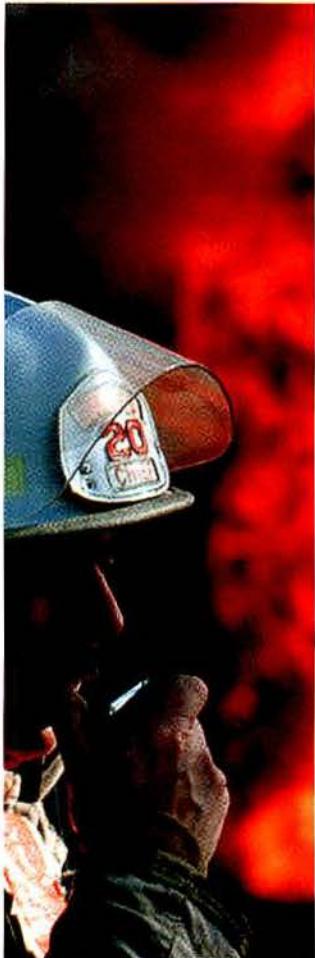
Heavily loaded cell sites with high interference typically have a noise floor in the LNA that is attributable to intermodulation noise rather than thermal noise.

ducted by companies developing superconducting products in cooperation with both wireless operators and large base station equipment vendors. These trials, which are ongoing, are done to document the benefits provided to wireless system operators across a variety of operational scenarios and to determine how first-generation products perform outside a regulated laboratory environment.

One such cellular trial occurred at an "antenna farm" where the participating system operator's cellular antennas serving a 300-square-mile area were co-located at the top of a 20-story building along with more than 50 other transmitters, including a competing cellular carrier's. Because of the large number of high-power transmitters, the cellular-band noise floor was elevated to an average value of -98dBm with peaks as high as -90dBm prior to the LNA. The result was unacceptable system performance, particularly at the outer layers of the designed coverage area.

Installing a superconducting filter removed most of the adjacent-band interference

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and reduced the noise floor to an average of -105dBm . This resulted in improved call quality for portable phones, a significant increase in total call traffic on the site and restoration of the cell coverage area to its initial configuration. Moreover, superconducting filters offer the potential to add additional voice channels at the site in the extended spectrum, which previously was avoided because of the high level of interference.

To prove the concept that superconductors can increase range while maintaining call quality, trials have been conducted at rural cellular sites that were designed for higher-power mobile phones. With most subscribers currently using lower-power portables, coverage holes were evident that resulted in dropped calls, poor voice call quality and areas where subscribers could not access the network.

The superconducting filter and cryogenic

LNA used in the test provided a 6dB improvement in receiver sensitivity, thereby extending the range of the cell about 35%. Extended base station range translates into increased customer satisfaction and increased revenue for the cellular operator in these environments.

A trial was conducted with a PCS base station with similar results. If PCS networks are designed from the beginning with superconducting products at selected sites, the extended coverage provided by increased sensitivity could result in a significant reduction in the number of base stations required to cover a given area. With each base station costing in excess of $\$200,000$, the total savings in deploying a network can easily pay for the cost of these products.

Conclusion

Superconducting products provide a tool to speed the site acquisition process by reducing restrictions on site selection criteria related to RF interference and coverage area. The advantages of speeding the

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in a significant reduction
in the number of base
stations required...*

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site acquisition process relate directly to competitiveness and profitability.

Field trials have quantified the benefits these products provide in high-capacity sites and harsh interference environments as well as the improvement in sensitivity to weak signals resulting in increased coverage. In addition, the trials have proven the suitability of first generation superconducting products.

Simultaneous with the field trials has been the development of business cases to also demonstrate favorable cost-benefit ratios. With the first commercial orders having been announced, superconducting products are already finding a niche in wireless networks. Future product improvements and price reductions that come from increased volumes will result in broader applications of superconductors to benefit the wireless industry.

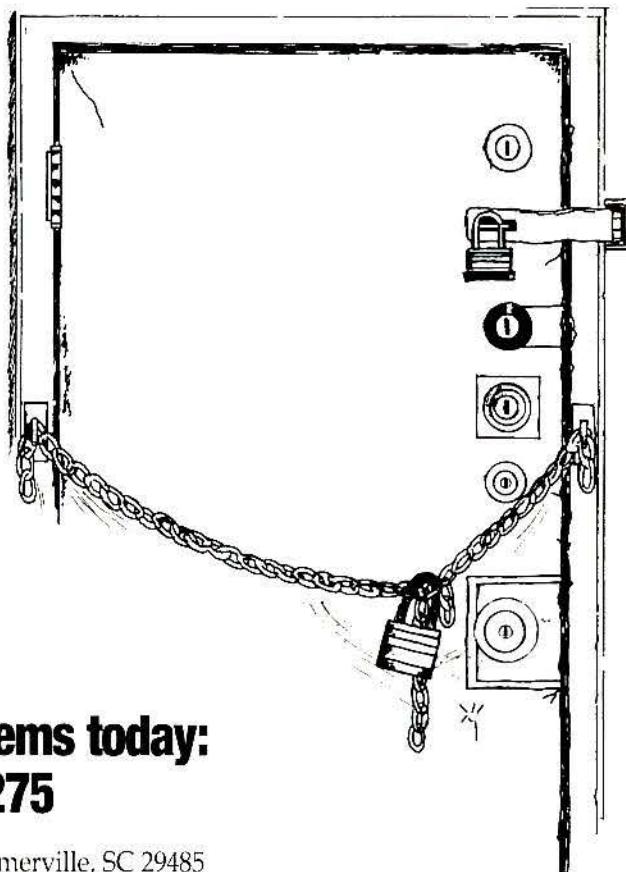
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Co-location helps carriers speed facility construction

The co-location of transmission facilities by competitors on a single cell site is overtaking the construction of antennas in clusters as the preferred method of satisfying residents opposed to sites being built in their communities.

By John E. Myers

The search for unopposed cellular cell site locations is becoming more difficult than ever. The build-out of personal communications services (PCS) this year complicates the search process. Many more cell sites are required, and the opposition is growing more vocal. The general public, local governmental bodies (zoning and permitting departments) and "NIMBY" (Not In My Back Yard) organizations are more aware of new sites. Moreover, regulations are being put in place to control the number of antennas and microwave dishes that carriers can

distribute on the structures being built.

The process of locating sites is often aided by finding existing cell sites and locating the new facilities close to them, resulting in clusters of antennas. The obvious advantage is that, where cell sites already exist, there may be less public opposition to additional structures because of the precedent. The obvious disadvantage is potential interference from other transmitters.

The Telecommunications Act of 1996 promised to make cell site placement easier, but it seems to have brought about opposition through zoning ordinances and moratoriums instead, which has slowed the permitting process. Communities question why there is a need for more sites, and

they are less tolerant than they were with only one. As many as four to nine competitors may want to place cell sites in any given area. (See Photos 1 and 2 below.) The local opposition to this expansion should be recognized, understood and responded to in a positive manner.

In the quest to build more sites, we are finding it necessary to educate the public and local governments as to why so many sites are required. Despite their attempt to be tolerant of the industry's needs, laymen and local officials rarely understand the technology involved. For instance, the public does not understand why all cell site transmission requirements for a given area cannot be built on one structure, in an out-of-sight location. We attempt to

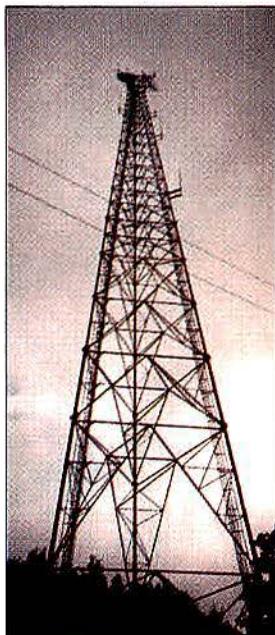


Photo 1. United States Cellular shares its Jefferson County, TN, tower with BellSouth Mobility DCS, a personal communications services competitor.

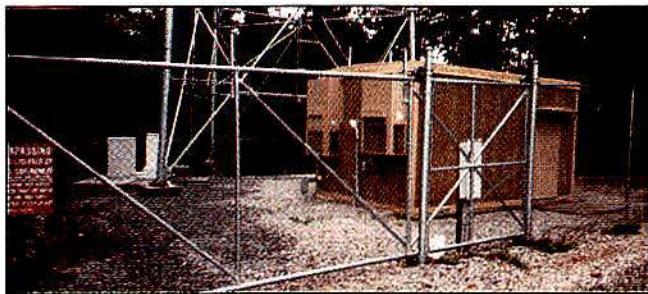


Photo 2. The building beneath the tower in Photo 1 is used by United States Cellular. The two white boxes to the left of the building are used by BellSouth.

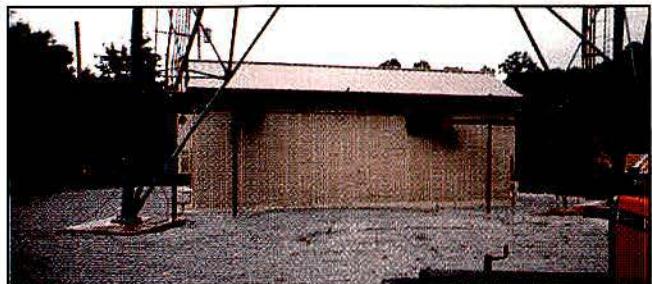


Photo 3. This United States Cellular building, positioned below the company's tower in Loudon County, just west of Knoxville, TN, is shared with the Loudon County Sheriff's Department.



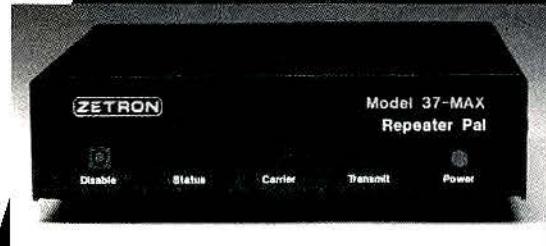
Photo 4. These are the tower and antennas shared by United States Cellular and the Loudon County Sheriff's Department.

Make Room! Make Room!

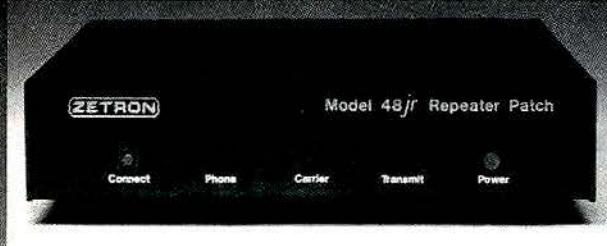
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communicate and to educate through public hearings and meetings so that not only may we gain permission to build a cell site, but also so that we can reach an understanding with the community and with potential customers.

Most site searches are initiated for the purpose of finding a suitable location for a vertical structure and a building, both surrounded by a fenced compound. A minimum of two cellular antennas is re-

quired on the structure, each served by coaxial cable. Typically, there is a minimum of one microwave antenna (dish) served by coaxial cable or waveguide. When no one opposes the site construction, the process can be accomplished in 30 to 60 days. With opposition, it can take months or years.

With each additional cable installed on the structure, it becomes more visible. As service and customers are added to the

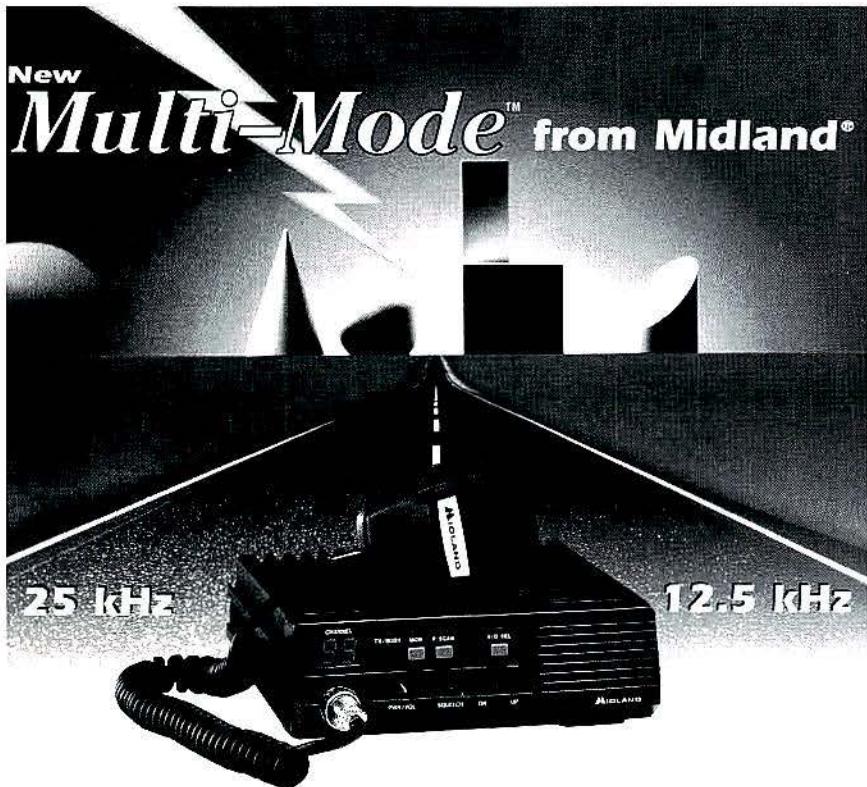
area, the antenna requirement could go to nine or more cellular antennas and four microwave dishes. If co-located facilities need additional antennas, the number could grow to more than 18 cellular antennas and eight microwave dishes with supporting cables. The public and government officials are more likely to accept additional antennas on an existing tower than they are the construction of a new tower because the change is less apparent.

We have taken steps to alleviate site location problems through co-location. The advantage of co-location is that one less structure needs to be built. When co-location is planned, an analysis is needed to verify whether the structure can support the added weight. Monetary benefits for carriers include the elimination of a cell site and property. Typically, there is a trade with the other carrier for a similar arrangement at one of its locations, making the co-location of two cell sites equal for both parties. Rarely, the co-location involves the use of a shared building. In that situation, the building may be divided with a solid or cage wall to limit access to the entire building while still accommodating heating and air conditioning requirements.

In our experience, the co-location of sites is a practical option that we approach on a case-by-case basis. We want to accept a new cell site location for every location we give, although not every request is acceptable, and all requests go through the same process as a new site location. The legally binding contracts previously negotiated with the original carrier must also bind the second carrier and must cover deeds, covenants, easements and rights-of-way. Both parties must be free to be released from the contract. The competitive advantage you have when you own the vertical structure is that you decide where to place the antenna, possibly giving you an edge over the competition.

Co-location is becoming more prevalent. (See Photos 3 and 4 on page 48.) It probably will be commonplace for the next several generations of communications structures and probably will not be limited to cellular carriers. Civil communications, including police and fire department radio transmission facilities, already are co-located on many of our sites.

Myers is group engineering manager for the Eastern Region of United States Cellular Wireless Communications, Chicago. The company manages and invests in cellular systems, providing service to 894,000 customers in 139 markets, and owning interests in an additional 66 systems.



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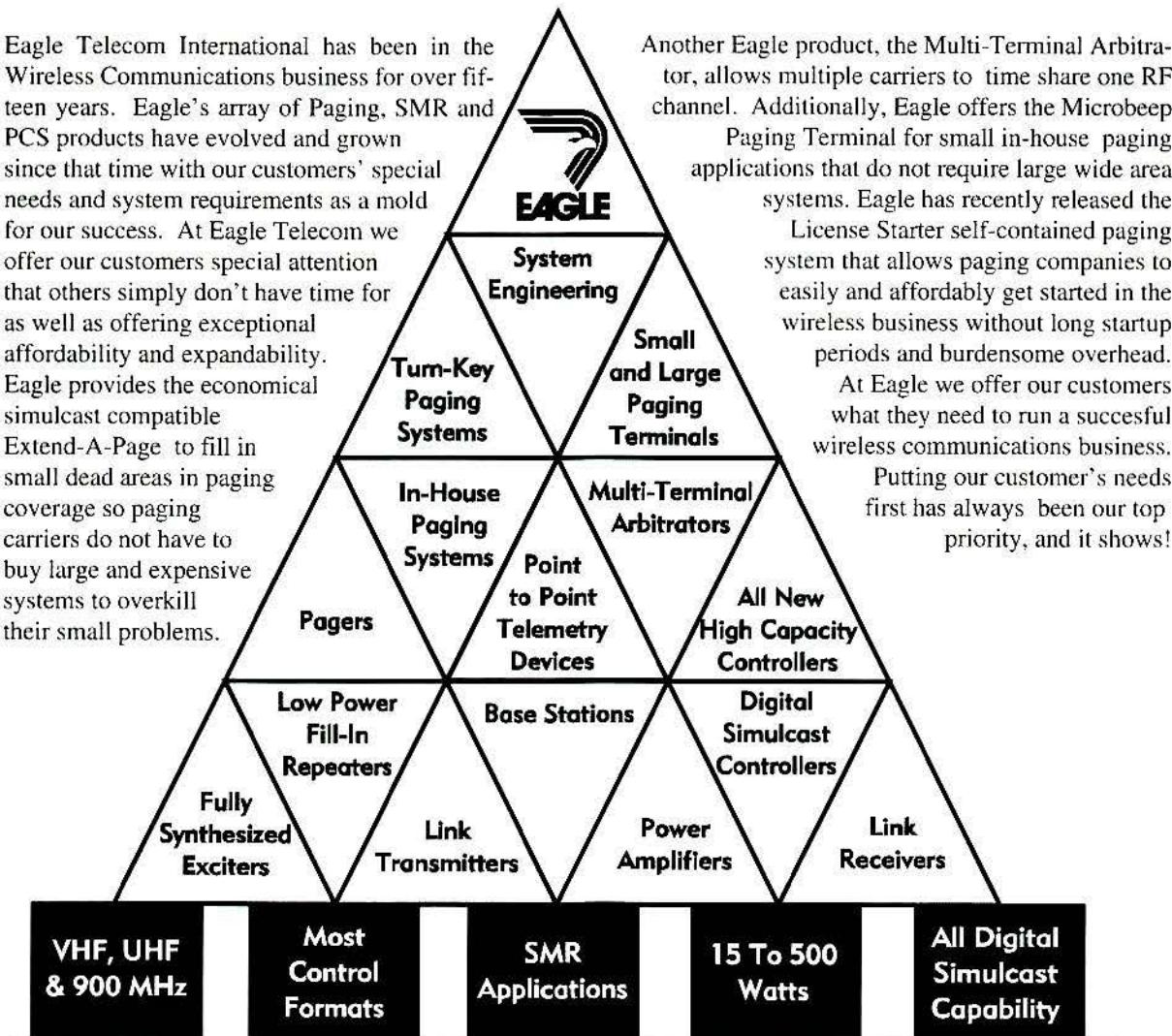
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Another Eagle product, the Multi-Terminal Arbitrator, allows multiple carriers to time share one RF channel. Additionally, Eagle offers the Microbeep

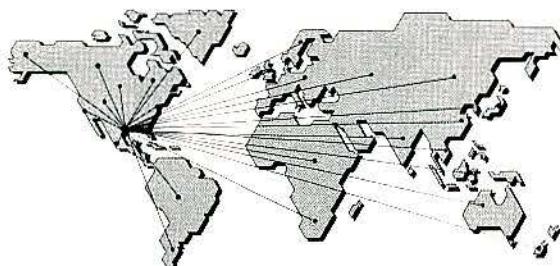
Paging Terminal for small in-house paging applications that do not require large wide area systems. Eagle has recently released the

License Starter self-contained paging system that allows paging companies to easily and affordably get started in the wireless business without long startup periods and burdensome overhead.

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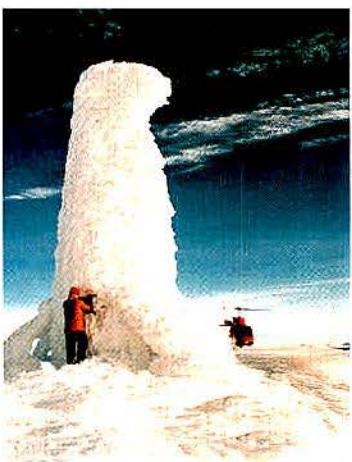
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Technically speaking

(continued from page 8)

got "warmed up" and would only cease when the tractor was throttled down and the radio was turned off and then back on.

I had the firefighter bring the tractor into the installation bay next to the radio shop so that I could begin troubleshooting with the radio still installed in the tractor.

With the tractor not running, I turned the radio on and found it to be operating normally. Then I started the tractor and let the engine run at low throttle for several minutes—still no evidence of trouble from the radio. Then I increased the throttle until it reached a point where the radio started "howling." Yes, indeed, I do mean "howling!"

As the firefighter had stated, the volume control had no effect on the howling. Next, I throttled down the tractor engine—but the howling persisted. I turned the radio off and back on, and the howling was gone. Now, what was the cause?

The next step was to connect a dc voltmeter across the battery and repeat the previous process. The initial battery voltage was around 13V, but when the engine was started and throttled up, the battery voltage started climbing. When the battery voltage reached the 16V threshold, the radio would start howling. Aha! The voltage regulator! The regulator was replaced and that took care of the problem.

Since then, I have encountered the same problem many times, and the voltage regulator has always been the culprit.

Again, check mobile equipment over a range of supply voltages in verifying complaints or in troubleshooting a problem.

In modern transceiver circuits, you will usually find several different supply voltages from the power supply or power distribution board. The digital circuitry generally operates from a 5V supply point. There may be other supply voltages as well (including the full battery voltage for mobile transceivers).

For base stations, the rule is the same—check all supply voltages. It is also a good practice to scope the supply voltage points to determine if the supply voltage is clean. The ripple component should be very low and free of spikes. Also, for regulated supply points, check to make sure the voltage regulation is within bounds.

Don't overlook using the spectrum analyzer as a signal-tracing tool when troubleshooting receivers and exciters. Watch the maximum input level to avoid damaging the front end of the spectrum analyzer. If the input impedance of the spectrum analyzer is 50Ω , then you can expect it to cause serious loading of the circuit under test. However, you can use

a simple and inexpensive low-capacitance scope probe (10/1) to reduce the loading effects. Any attenuation caused can be reduced by the use of a preamplifier between the scope probe and the analyzer input.

This procedure works particularly well if you use a known good transceiver to establish reference measurement levels ahead of time using the same test equipment, including probes and preamplifier. This establishes a good benchmark for future reference and is particularly valuable if you service many transceivers of the same model. There are manifold returns on the time used in making such measurements.

Many manufacturers' spectrum analyzers also offer a special preamplified, high-impedance, signal-tracing probe that allows the analyzer to be used for signal tracing in circuits with minimal loading effects. Such probes are called *active* probes. The probe supply voltage usually comes directly from the spectrum analyzer.

Conclusion

The best advice in troubleshooting is to *keep an open mind*. Let your troubleshooting tests and measurements lead you to the problem. Don't guess what you think the problem may be and then set out with test procedures to prove that you are right.

No test procedure is useless. Even though it may be way off base, it will provide you with some information. However, each test procedure should lead you one step closer to the problem part or board. Don't rule out any component based on appearance alone. No matter how innocuous it may look, it *can be bad*! Electronic components often look like new on the outside, but are totally "zapped" on the inside!

Make sure you thoroughly understand the circuit you are troubleshooting. Without an understanding of how the circuit *works*, you will not be able to understand what makes it *not work*.

Know and understand the limitations of your equipment and the situations where false readings can occur. Know when to get a second opinion by another method.

Keep your test equipment properly maintained and calibrated. Keep fresh cells in battery-operated equipment and have spare batteries on hand. Keep your test leads and probes in good condition.

By following some of the basics set forth in this series, along with hard work, you can become a better troubleshooter. By successfully meeting the challenge of each troubleshooting job, you gain experience, knowledge and confidence that will allow you to successfully meet greater challenges.

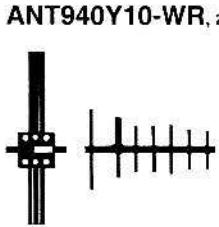
Until next time... *stay tuned!*

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ANT940Y10-WR, also known as Yagi Antenna. born 6-24-74; 2.5 lbs; 24" x 9"; Known associates: likes to hang out in dingy, dismal areas. hvy bld; blk TXYLAN coated. Known to violently resist corrosive gases, ultraviolet radiation, salt spray and acid rain. Wanted for directional control.

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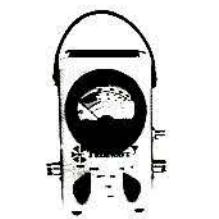
Industry Top Ten Product



TC860, also known as Celco Ceramic Trunking Combiner. born 5-25-91; size 7x19x14"; 36 lbs; rugged bld; 125 watts, alum finish. Wanted by SMR operators who want only the best.

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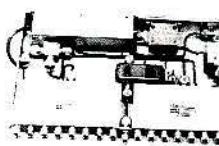


Model 44AP, also known as the Broadband RF Wattmeter. born 6-11-78; weight 4 lbs; rugged bld; 500 watts; gray comp; operates alone, no known associates; distinguishing marks: leather band on top, sample port right side. No known enemies, has been spotted worldwide.



R. Middle

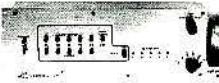
Industry Top Ten Product



TWR816-860-1RTT, also known as Compact Receiver Panel. born 8-14-93; exceptional small build, likes to associate with multiple frequencies. Quiet 2.5 dB noise; modular; has been known to redundantly switch to 2nd channel if injured; likes living in harsh locations. Wanted for resisting interfering signals.

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Industry Top Ten Product



PM5C1S, also known as Automatic Alarm Panel. born 2-23-81; brushed alum; 1.4 lbs; 19"x3.5"; Known associates: likes to snitch on bad trans & ant; needs to be placed inline; violently resists high VSWR; likes power. Do not approach, will call you.

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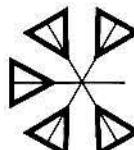
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TS4680, also known as Cross Band Coupler. born 2-10-86; size 6.6 x 1.5 x 0"; 1 lb; hvy const; 400 watts; blue finish; tower mountable. Wanted by tower operators for multiple transmissions of 450-860 equipment.



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Industry Top Ten Product

ANT450D3, also known as Dipole Array Antenna.

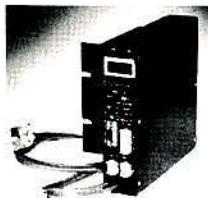
born 9-14-58; known associates: other antennas in other freq bands and gain. hvy bld; blk TXYLAN coated. Known to violently resist corrosive gases, ultraviolet radiation, salt spray and acid rain. Wanted by tower operators with the worst possible problems.



PRINTS
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Industry Top Ten Product

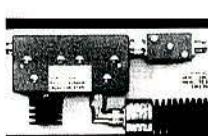
PMU1C1S, also known as Power Monitor Unit. born 4-23-95; sml bld; blk, red eyes glow in dark. Wanted for monitoring ant VSWR and TX power. Notorious for working multiple freq in all bands. Known associates RS232 and RS485.



R. Index

Industry Top Ten Product

TS450PB1, also known as IM Suppression Panel. born 7-12-75; rugged bld; black & blue marks on body; 5 lbs; 19"x5.25"; 50 watts, 30 dB; wanted by transmitters for killing intermodulation; likes isolation. Reward is offered for protectionism.



PRINTS
AVAILABLE

Industry Top Ten Product

TATC8944, also known as Cellular Auto Tune Ceramic Combiner. born 4-1-92; size 10.25W x 10.75H x 12.75"; 36 lbs; heavy bld; black finish; easy to install. Wanted by Cellular operators for retrofit or new installations, both in USA and foreign countries.



L. Thumb

Big hand for the little investor

A company does not have to be a telecommunications giant to get a seat in the high-stakes game called the 220MHz-222MHz auction. A thorough understanding of the rules and some foresight can increase the ability to compete.

By Kathleen A. Kaercher

Ready to play some high stakes poker? The FCC's getting ready to cut the cards in the 220MHz-222MHz auction, and everyone's invited to take a seat at the table. Although the house will make sure nobody's dealing from the bottom of the deck, players ought to know the game before they take a chair. This might be one game where even a small investor can win a pot.

Your stake

Every player's got a stake—that poke

Kaercher is an associate in the law firm of Brown and Schwaninger, Washington, DC.

of cash used to get started. In business, that stake is called "financing." Big gamblers from Wall Street just take the dough out of petty cash, but "low-rollers" should let the house help them. The FCC's financing plan for small businesses is fairly generous and allows purchase of a license over time. As long as the payments are made, the house will cover. The one thing that the house won't cover is the ante. In this game, the ante is called the "upfront payment."

The ante

As with all poker games, the size of the ante is associated with the potential size of the pot to be won. The FCC estimates the size of the pot by figuring the number and value of the licenses the players want.

The value of the licenses is calculated by the population size of the market and the extent to which the license to be auctioned is encumbered by existing licensees. The term for this rough valuation is "activity units." Activity units increase the value of the license to be auctioned.

The upfront payment is converted into activity units as well. That way, the house is playing with the same bidding medium as each player. Stated another way, activity units are like chips, which have no value except the agreed upon value between the players and the house. The upfront payment buys chips with which each bidder plays, and players may only bid on those licenses for which they have paid sufficient upfront money—sort of a table minimum. Chips are bought via an

Support for Olympics infrastructure relies on narrowband 220MHz

One of the best American teamwork success stories from the 1996 Olympic games in Atlanta was the winning performance of the SEA 220MHz systems.

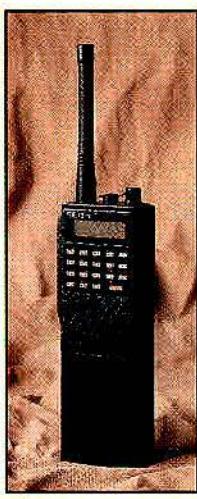
Spectrum availability and coverage challenges of the rolling hills around Atlanta made the choice of a narrowband 220MHz radio system an obvious one. Marietta Communications installed the 60-channel system with SEA ESP-1000 repeaters, Telewave combiners on each site, TNT Logic Controllers on all systems and Andrew helically corrugated cable. Each site has a varying number of channels, from at least five to the 20 channels at Broadcast Services' downtown site at Westin Peachtree Plaza. Marietta has several hundred permanent customers on its system who cite the lower

monthly fees for dispatch services as a primary reason for choosing narrowband technology.

With the 220MHz system, couriers had the ability to operate on three different frequencies, with wider coverage and lower cost than the existing 800MHz system or cellular.

Jeff Stewart with ATL Courier observed, "No matter where you used the radio, you could still hear. Background noise did not come through with the SEA radios. We grabbed the channel 90% to 95% of the time, even 18 miles from the repeater. We could operate on the trunking network and talk to the office or anyone else on the 220 frequency."

Marietta used two systems—one downtown and one at Sawnee Mountain for the northern Olympic locations—effectively covering an area



SEA 700 portable

about 70 miles long by 60 miles wide. Marietta put about 250 additional mobiles and portables to work during the Summer Games. Users included the Olympic International Committee and corporate users such as NBC, AT&T, Nike and Coca-Cola.

The Olympic challenge for one of Marietta Communications' customers, ATL Courier, was delivery soon after 6 a.m. each day of more than 250,000 copies of the *Sports Illustrated Daily* to about 20 Olympic venues. These venues ranged from the Olympic Stadium downtown to the site for rowing and kayaking at Lake Lanier, more than 20 miles north of Atlanta. Seventy "walkers" or on-foot couriers and 25 large trucks formed the backbone of the ATL Olympic operation, and all needed constant communications to monitor traffic, coordinate unloading and remain flexible to security requirements.

—Elaine Baugh
E Comm International for SEA

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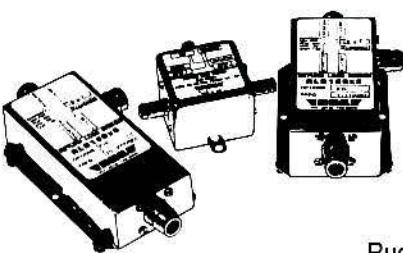
FCC Form 175 application and a cashiers' check. Mistakes made in completing the Form 175 can disqualify a player from the competition.

So, supposing an upfront payment is \$10,000, that might secure, as an example, 1 million activity units to be used toward any license or group of licenses on which the house has placed a value of as much as 100,000 activity units. One benefit, compared to real poker, is that players who fold in the auction get their antes back. Any interest the house makes on the ante while it is held as security goes to the Telecommunications Development Fund for assistance to small business.

House rules

Each game or auction has produced different rules. The FCC's rules for each PCS auction have been a bit different than the ones before, which were different than the ones for 900MHz SMR licenses, which will be different than future auctions. The FCC is still tinkering with the game, and the changing rules reflect the dynamic nature of the FCC's ongoing experiment. So, maybe "threes will be wild" in the 220MHz-222MHz auction, or maybe the small business financing rules will be altered.

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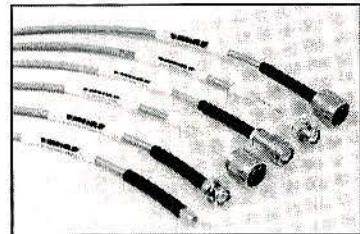
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One source of variation has been the amount of activity units that are required to be used by the players, expressed as a percentage of each player's ante. For example, the FCC required that bidders use as much as half of their activity units at Stage 1 of the auction. So, if a player bought 100,000 activity units, at least 50,000 of those units had to be bid from the beginning. At Stage 2 of the same auction, as much as 75% of the activity units had to be committed, and 95% at Stage 3.

Failure to bid the required amount of activity units drew a penalty—a loss of a "waiver." Each player received five waivers to start the auction. When all five were used up, the player was out. Another form of penalty was the forfeit of a portion of activity units with which to bid, but the FCC did not take the upfront money players paid to buy the activity units.

Beyond the first round, the FCC also has mandated minimum bidding or raises. So, a dollar has not been enough of an increment to top the previous bid. The Commission can set the house rules for a raise to be a percentage (similar to compound interest), or a flat amount or whatever increment it deems appropriate. This procedure can send bids skyrocketing for prime markets.

Preparing for battle

Bids can be placed by telephone or computer, with the latter being the most popular for many reasons, including speed, security and accuracy. Computer bidding requires a system with at least 8MB of RAM (A system with 16MB of RAM can be used later to file Form 600 electronically) and 12MB of hard drive space. For adequate processing and sending speed, the hardware should have a 386 CPU (or faster) and a 14.4kbps modem.

Dialing up to bid will hook you into the FCC's auction department for the low, low price of only \$2.30 per minute. If this seems a little steep, it is, especially when participating in as many as nine rounds a day, requiring connection for almost the entire business day. Our clients had collective heart failure when this part of their bill was presented.

To avoid card sharks and rascals, the FCC has installed an elaborate security system that requires the use of four different passwords and identification numbers that must be entered before the bid will be accepted. It's helpful to begin the bidding process early to make sure there is sufficient time to get through the maze; when the time comes for a round to close, it closes. The FCC isn't going to sit around and wait while players rearrange their cards.

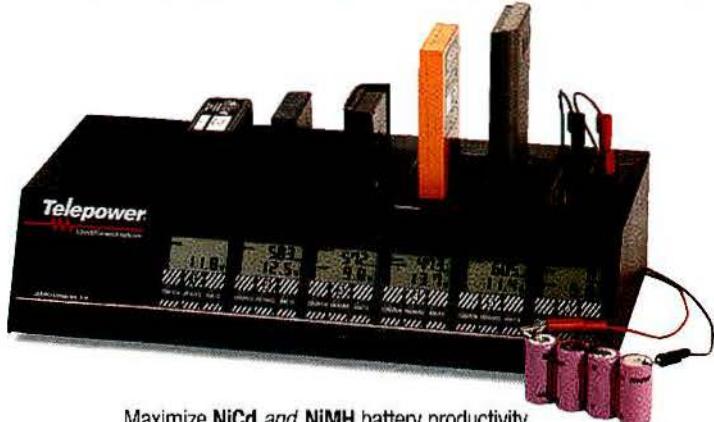
While playing, try to devise a workable strategy with articulated objectives. Just jumping around from market to market hoping to "win" something can be counterproductive and expensive. This isn't to say that you won't have backup plans or alternative choices, but have a notion about what you are trying to accomplish. It will save time and will greatly reduce panic.

When faced with a bidding mistake, like Atlanta Trunking Associates' now fa-

mous \$125 million bid for a block of 900 MHz frequencies, withdraw the bid and tell the FCC as soon as possible. Although a fine will be assessed, the chances of negotiating a reasonable settlement that won't bankrupt your company are increased.

How the auction closes is another facet that can change from auction to auction. The 900MHz auction continued on until there were no more bids, anywhere, for any license. Maintaining the top bid in

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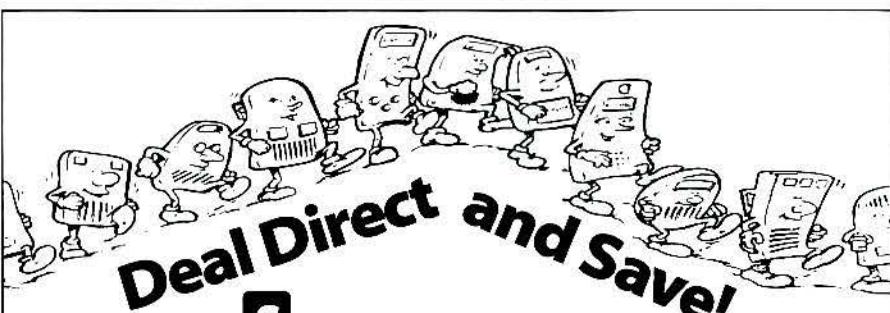
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the Omaha market for 30 consecutive rounds didn't guarantee a win. The game continued until nobody bid for anything and, up until the end, Black Bart Communications still had the opportunity to top you. That meant being on top of each and every round, even if just to make sure that your bid was still good.

Designated player

The auction waits for no one. From Dec. 5, 1995 until mid-April 1996, the 900MHz auction continued without pause at an ever-increasing pace, first with one or two rounds a day, and as many as nine rounds a day at the end. Those who are unwilling to lock the doors of their businesses and hole up in a cell for 90 days should probably designate alternative bidders to assist them. The negative effects of an owner neglecting a business to participate in every step of an auction justify the cost of hiring a professional.

It is also a good idea to have one designated bidder situated in Washington, DC, during the auction. If the bidding hits a glitch (which has happened) it may be necessary to obtain new identification numbers and codes to continue. Those codes can only be obtained in person, by a designated bidder with proper identification, at the FCC offices. If your office is in Seattle, that means you will miss every round until you can get on a plane and fly to Washington to fix the problem.

Line up a Washington-based designated representative before the bidding begins and list that person on your application. That way if your dog dies, or if you suffer from nervous exhaustion in the middle of the auction (or if you would rather spend your time running your business rather than participating in the complex and fast-paced flurry of activity that is the nature of FCC auctions), "the show will go on."

Defining victory

As a final note, remember that this is an *auction*. If you don't get a license, you get back your upfront money. Therefore, there is no "penalty" for coming up empty-handed. Victory is achieved by paying *less* for a license that you believe is worth *more* than the amount paid. It is not achieved by paying more than it's worth.

There has been a tendency to refer to auction "winners" and "winning bids" and "awards" of licenses as though a competition existed where the unworthy are unmentioned. In this poker game, there are no winners and losers. Just people with the guts to try, the vision to achieve, and sometimes, the intelligence required to know when to fold.

Raising the white paper flag

By Robert H. Schwaninger Jr.

Lately, the FCC has carried on an internal dialogue regarding the future of private radio, private radio services and private radio spectrum. As you might expect, these conversations were mainly... well, private. But in a nearly unprecedented move, the Wireless Telecommunications Bureau allowed some of the discussions to become public.

David Wye, a bureau adviser, circulated a draft of a white paper on the history and future of private radio that is intended to be submitted to the commission. He invited public comments by circulating his unfinished efforts to industry associations and others, requesting suggestions, corrections and any editing help that might be offered. His instructions carefully noted that the draft was just that, a draft.

Schwaninger, MRT's regulatory consultant, is a partner in the law firm of Brown and Schwaninger, Washington, DC. He is a member of the Radio Club of America.

and that it was not to be quoted, cited or whispered about without permission.

For those of you who don't know what a "white paper" is, I offer the following easy definition. A white paper is a trea-

*The white paper ...
suggests that private
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greater efficiencies in the
operation of numerous
industrial, public safety
and commercial entities.*

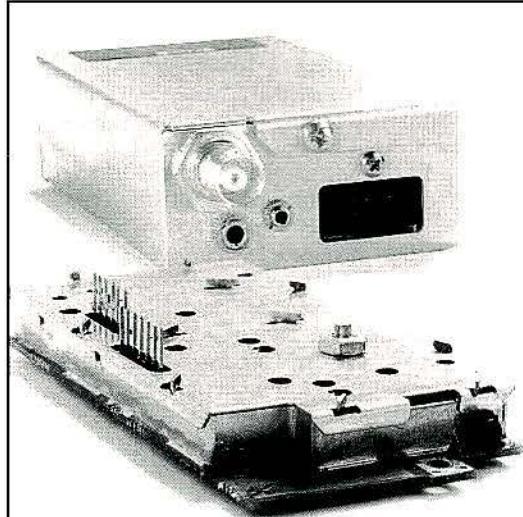
ture printed on regular paper, with fewer footnotes and a shorter bibliography, and its author doesn't insist on being called "Doctor." I, for one, am grateful that Mr.

Wye stuck to his subject without any pretense of science or theory.

The white paper makes for interesting reading. It chronicles the history of private radio and points out the rapidly changing nature of this industry segment. It notes the many and varied uses of the spectrum to serve the unique needs of licensees. Further, it suggests that private radio has provided greater efficiencies in the operation of numerous industrial, public safety and commercial entities.

There are, however, three sections that appear to have created controversy, and understandably so. First, the white paper poses the question of whether private radio licensees and users might be better served by commercial carriers that obtain authority via auction. The short answer is "NO." The longer answer involves expletives that the editor of this publication will not allow.

As the white paper points out, the cost of obtaining commercial service (averaging \$50 per month per unit) is too high for most private entities to justify,



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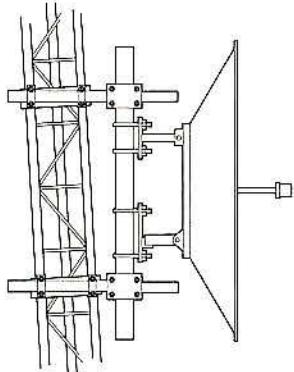
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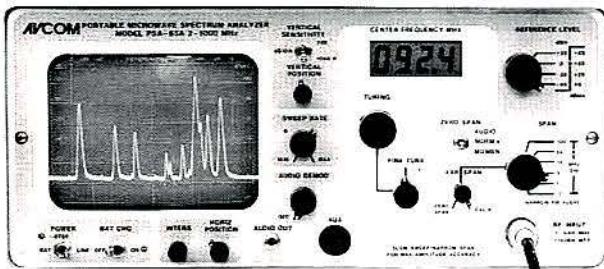
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whereas the cost of constructing a private radio system, uniquely designed to meet the needs of the licensee, often is fully justified. Nor, as Mr. Wye pointed out, would commercial systems be designed to fully meet the needs of traditional private, industrial and public safety users; therefore, getting service from a commercial provider would be more expensive because it would be, in effect, a "cookie-cutter" service not designed to meet the needs of the private consumer.

The second controversial section of the white paper involves spectrum efficiency. Am I the only person in America who has noticed that the FCC believes that spectrum efficiency for commercial carriers is best obtained by authorizing wideband operations, while still claiming that spectrum efficiency for private entities is best obtained by narrowband operations? This inconsistency in the area of attaining greater spectrum efficiencies has always confused me. The white paper does not alleviate my addled mind. It merely reinforces the dichotomy.

The white paper (remember, it's only a draft) suggests that the use of private radio spectrum might be improved by using code-division multiple-access (CDMA) or time-division multiple-access (TDMA) modulation or spread-spectrum modulation for high-speed data or digital transmissions. Then, another section of the white paper refers to efficiencies gained through narrowing the bandwidth for operation. I humbly invite letters to the editor of this publication from some helpful reader who might explain how these transmission or modulation methods might be achieved effectively with the use of a 6.25kHz-wide private radio channel. Maybe that person also can explain how I might fit into my old Little League uniform.

The third controversial portion of the white paper involves the commission's concern in receiving "value for spectrum." The white paper admits that the current yardstick for measuring value received for spectrum is auction receipts. What a pity. That comment standing alone is a testament to the myopia suffered by some elected officials.

If a local community gives away unused land for the

construction of a new plant that brings jobs, tax revenue and positive development to the area, that effort is applauded as being good for the whole community. Hell, the Department of Housing and Urban Development has done it for years—and puts itself on the back for each effort. Economic vitality is gained and services to the public are provided; but the same government that will provide raw land and unused buildings for private improvement seems to believe that giving raw spectrum to businesses and public entities is somehow immoral.

I agree with that view—if the spectrum is merely going to be warehoused by a company that only wants to leverage the licenses to sell stock. Besides, whether the licenses were obtained at auction, by application or by musical chairs among CEOs is irrelevant to my conclusion. Spectrum that is used to provide services to the public, to provide greater protection to citizens or to enhance the efficiency of industry provides a greater “value” to the United States and to the public than any net proceeds from auctions.

During this presidential campaign, we will be treated to candidates who claim that they back policies that create jobs. Perhaps it would be helpful if we told

these candidates that auctions do not create jobs. Providing service to the public creates jobs. To be totally radical (I might

During this presidential campaign, we will be treated to candidates who claim that they back policies that create jobs. Perhaps it would be helpful if we told these candidates that auctions do not create jobs. Providing service to the public creates jobs.

as well live up to the claims of my detractors), I suggest that it would be nice to ensure that such value is received by demanding performance bonds from auction

winners and companies that received extended implementation schedules for construction of radio systems. That way, the American public would not be left holding the bag each time a corporate speculator says, “Trust me.”

Entities that default should pay the value of the performance bonds into the Telecommunications Development Fund (TDF). The what? That’s the fund that the FCC was supposed to start up to support the efforts of small business. I requested a seat on the board and was nominated by many caring persons. Since that time, the FCC has been strangely silent about the fund and its board, including the selection of board members.

As further funding, TDF should receive the profit the commission gets by operating its 900 telephone line for auction participation. Auction participants’ phone bills can reach thousands of dollars. The FCC’s \$2.30 per minute charges are about equal to the Psychic Hotline or 1-900-HOT-BABE and are about as rewarding. Which makes me wonder, is the wireline carrier getting its customary 50% cut of that money? As Aretha Franklin once asked, “Who’s zoomin’ who?”



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Wireless location services for wireless 911 is big topic at PCIA's Personal Communications Showcase

Because a growing number of 911 calls are originating from cellular phones, the FCC adopted a *Report and Order* in June 1996 that created rules to govern the implementation of wireless 911. The rules state that within 18 months (Phase 1) of the original order, cellular licensees must implement wireless 911 services similar in capability to wireline E911 service.

In response to these rules, Tandem Computers, Cupertino, CA; SignalSoft, Boulder, CO; and SCC Communications, Boulder, have developed network-based

Wireless Location Services (WLS) for wireless 911 and location sensitive billing. Increased competition in the wireless market and FCC mandates brought the three companies together.

Tandem's Himalaya computer platform is used to support wireline Enhanced 911 (E911) service for more than 160 million people throughout North America. SCC Communications' E911 application, running on Tandem's platform, provides information management and delivery support in 35 states and Canada. SCC's service al-

lows integration of Wireless 911 calls into the existing landline E911 infrastructure.

Motorola's Cellular Infrastructure Group, Arlington Heights, IL, also is offering its Wireless E911, an intelligent network-based solution that will allow automatic location identification of wireless 911 calls. The technology ensures that the cellular 911 call is routed to the nearest public safety answering point (PSAP) and that the emergency dispatcher has the phone number of the cellular user for call-back purposes.

Allen Telecom Group's acquisitions

At PCS in San Francisco, Erik van der Kaay, president of Allen Telecom Group (ATG), Cleveland, said the company's recent and pending acquisitions position it as a leading global provider of an integrated and comprehensive line of telecommunications products and test equipment.

ATG, founded in 1953 as The Antenna Specialists Co., merged with Grayson Electronics in 1990 and Decibel Products in 1992 and purchased FOREM S.p.A. in Italy and MIKOM GmbH in Germany in 1994. In May, ATG's parent company, the

boost company's global position

Allen Group, acquired Tekmar Sistemi in Italy, and in August announced plans to acquire Signal Science (SSI), Santa Clara, CA.

Van der Kaay said the Tekmar acquisition gives ATG greater technological capabilities in the repeater and in-building antenna markets and provides ATG access to Tekmar's capabilities in fiber-optic technology. SSI's signal analysis and characterization, coupled with its wideband digital capabilities, would allow ATG to become a leader in fraud prevention technology.

PageNet chooses Centigram's MobileManager applications

PageNet, Dallas, plans to purchase MobileManager from Centigram, San Jose, CA. PageNet expects to test the services on a limited basis this year and is considering future widespread commercial deployment. MobileManager is the technology platform created by the Centigram and Priority Call Management partnership.

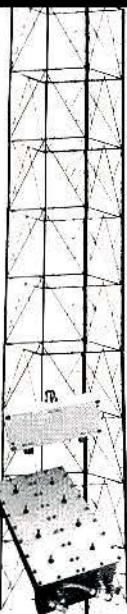
The MobileManager product mix includes personal number, debit card, prepaid cellular, credit/calling card and call-back services.

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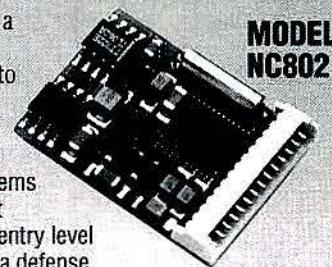
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PCIA to manage code administration for Flex wireless messaging

The Personal Communications Industry Association (PCIA) will assume code administration management of the Flex family of messaging protocols developed by Motorola's Messaging Systems Products Group (MSPG). PCIA will independently process applications for long addresses, Simulcast System Identification (SSID) codes, Service Provider Identification (SPID) and Network Identifiers (NID) from messaging devices and system manufacturers, paging service providers and governmental entities.

PCIA has initiated software design of the code administration program and will review and process all applications on a

first-come, first-serve basis. The anticipated start-up date for the program is January 1997.

In related news, Samsung and Matsushita announced at PCS that they have entered into Flex protocol licensing agreements with Motorola. According to its agreement, Samsung plans to develop high-speed Flex pagers for distribution worldwide as early as 1997. Matsushita Electric Industrial, which manufactures and sells consumer electronics and electronic products under the trade names of Panasonic and Technics, as well as others, will also use its license for the manufacture of Flex high-speed pagers.

Dataradio, E.F. Johnson, Motorola cooperate on wireless modems

Dataradio, Atlanta, E.F. Johnson, Burnsville, MN, and Motorola, Schaumburg, IL, will cooperate on fully compatible radio modems with interoperability for wireless telemetry, SCADA and other industrial applications. The Dataradio Interoperability Standard (DIOS) ensures that high-speed wireless modems will be compatible and interchangeable with stan-

dard mounting plates, RS-232 pin-outs and on-air interoperability. DIOS is based on modem, data link design and microcontroller software. Interoperability gives customers multiple sources of supply. The three compatible modem lines feature 1,200bps-9,600bps operation, powerful remote diagnostics and control and eight synthesized radio channel selection.

Calhoun County tests Motorola's advanced digital technology

The Calhoun County Emergency Management Agency will field test Motorola's digital radio technology. The installation in Alabama's Calhoun and Talladega counties represents a significant step by Motorola toward full compliance with Project 25, the U.S. public safety community's standard for trunked radio systems. The beta system's common air interface, which allows radios to interoperate, will be Project 25-compliant. Ultimately, different agencies with compliant radios will be able to interoperate on trunked systems.

Calhoun County awarded Motorola the \$14.2 million contract in July for an Astro 800MHz digital communications system. Because the county will be among the first public safety agencies to use the technology, they also will be part of the two-week field trial. The tests will focus on the operation of the control and dispatch systems and will test the new portable Astro radios. Three of the six simulcast sites will be activated, and Motorola will provide 11 engineers to analyze the system operation. County technicians will provide additional assistance.

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Motorola announces winners of 'Pagers for Children' design competition

Motorola's North American Paging Subscriber Division, Boynton Beach, FL, has announced the winners of its second annual pager de-



First prize.



Second prize.



Third prize.

nality, flexibility and future vision. More than 140 entries were submitted.

First prize was a cartoon-like pager in a kangaroo-like pouch designed by Chih-Hong Hsieh, a student at the Pasadena, CA, Art Center College of Design. Second prize was awarded to Mirzat Koc, who attends Pratt Institute in New York, for his soft, round pager with easy messaging access. Third prize went to Steve Sigler at California State University at Long Beach for his pager with interchangeable, imaginative protective casings.

The first prize winner received an internship at Motorola's design facility in Boynton Beach, \$5,000 and a Motorola pager.

Glenayre activates InFlexion in successful San Francisco trial

The Wireless Messaging Group of Glenayre Technologies, Charlotte, NC, has installed and activated a complete InFlexion voice messaging system. In tests conducted in San Francisco during August, Glenayre delivered voice messages to a Tenor voice pager on PageNet's VoiceNow service. Don Gayton, Glenayre's senior vice president of engineering, said that the successful voice transmission in a real-world system was a confirmation of the technology and a key step toward the deployment of a commercial system.

Voice messages were received by a GL3000 wireless messaging switch through the PSTN and transmitted to a GL#100 RF Director over a TCP/IP network using Glenayre's WMtp protocol. The RF Director sent the messages to the correct transmitter site via a public frame relay network. A GL-9501 base station controller synchronized the signals and sent them to the voice pagers via GL-T9501 linear transmitters. The pager then acknowledged receipt of the messages by responding to Glenayre's GL-R9000 receiver.

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Midland's U.S. business is sold to Intek Diversified

The U.S. land mobile radio business of Midland International, Kansas City, MO, was sold Sept. 20 to Intek Diversified, Los Angeles. Midland International is wholly owned by Simmonds Capital Limited (SCL), Willowdale, Ontario, Canada, which owns a controlling interest in Intek. The transaction is expected to have little effect on the operations of the acquired business, which has been named Midland USA.

Under agreements among Securicor Group, Surrey, UK; SCL; and Intek, Intek is expected to acquire a subsidiary of Securicor in exchange for enough Intek stock so that Securicor will own 60% of Intek. (SCL will retain an 11% ownership interest. Intek stock is publicly traded.) Through Intek, Securicor will control Roamer One, an Intek subsidiary with a specialized mobile radio (SMR) airtime business; Securicor Radiocoms, a UK company that manufactures linear modulation equipment first used in the United States at 220MHz and suitable for other frequencies; and Midland USA.

In the meantime, Securicor has agreed to lend Intek as much as \$15 million to operate Midland USA. As collateral, Midland USA has pledged its assets, and Intek has pledged its ownership in Midland USA.

NDS wins AVL contract from Colombian company

Navigation Data Systems, New Orleans has been awarded a contract for a Fleet-Trak 1000 automatic vehicle location, mobile data and computer-aided dispatch system by RF Tecnologías, Cali, Colombia. The system is being installed as a public-use system with individual companies buying or leasing mobile equipment and dispatcher workstations that will communicate over a common radio network.

The radio network will include several conventional radio sites linked to the control center by microwave. The Fleet-Trak 1000 system will control the data system with transmitter steering algorithms to continuously track the vehicles as they move from the coverage of one site to another. The position reports and messages from the vehicles will be routed to the individual companies from the control center using telephone lines. The system supports two-way data.

Interaction between wireless phones, medical devices discussed at electromagnetic compatibility forum

Scientific researchers, industry and other government experts gathered at a forum in September to present study results, discuss and resolve electromagnetic compatibility (EMC) issues.

A major focus of the one-day conference was research results from recent studies of interaction with hearing aids and pacemakers by digital cellular phones. Results of in vitro tests done by Mount Sinai Medical Center, the Food and Drug Administration and the University of Oklahoma's EMC Center indicated that the interaction only occurred with some pacemaker models and disappeared as soon as the phone was taken away. One study demonstrated how a broadband filter placed within the pacemaker eliminated all interference from wireless phones.

Researchers provided results of the major clinical study completed recently by the University of Oklahoma, and other clinical tests conducted with hearing aid users by Gallaudet University and the City University of New York.

A panel of government and industry experts addressed EMI test procedures for hospital equipment, hospital policies for managing radio frequency sources and prevention of medical device malfunctions due to EMI. The FDA's new medical device user reporting regulations was also discussed.

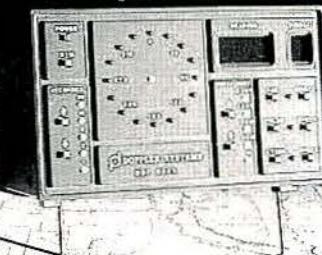
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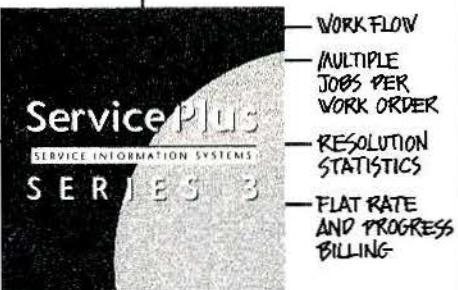
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Product/Logo Directory

For more information on the products and services offered by the following advertisers in this issue, circle the corresponding number on the Fast Fact Card found on page 101.

AF Comm Supply

AF Comm Supply distributes quality wireless communications equipment from more than 50 leading manufacturers. Andrew to Zetron, antennas to Z-matchers. Free catalogs and quotes available.

Circle (351) on Fast Fact Card



Allen Telecom Group

Allen Telecom Group produces base station equipment, including amplifiers, antenna systems, duplexers and multiplexers; signal coverage expanders, including boosters, microcell systems and repeaters; wireless measurement instruments; land mobile, cellular and PCS antennas; and systems integration.

Circle (352) on Fast Fact Card

Andrew Corporation

Andrew Corporation is an international supplier of communications equipment and services. Andrew offers coaxial cable, connectors and accessories for wireless communications applications.

Circle (353) on Fast Fact Card



A.P.E. South

The SMD-1000 Chipmaster radio and pager repair system provides low-temperature, high-power rework of all cellular and pager products enabling controlled removal and replacement of all components.

Circle (354) on Fast Fact Card



Centurion International

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Circle (355) on Fast Fact Card

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Communications Specialists

Manufacturers of encoders and decoders in CTCSS, DCS, two-tone sequential, shared repeater tone panel, Morse station ID and chip resistor/capacitor prototyping kits.

Circle (357) on Fast Fact Card

DuraComm

Two-channel programmable tone and voice pagers in VHF, UHF and lowband. Switchmode power supplies from 7A to 75A, including 12Vdc, 24Vdc, 110Vac/220Vac switchable. Modular power systems.

Circle (358) on Fast Fact Card



Eagle Telecom International

Eagle Telecom International's full line of paging products includes receivers, fully synthesized transmitters, solid-state power amplifiers, base stations, transmitter controllers and low-cost License Starter paging systems.

Circle (359) on Fast Fact Card



Hustler

Hustler offers a complete line of single- and dual-polarized PCS panel antennas as well as base antennas for cellular, trunking, paging, UHF and VHF applications.

Circle (362) on Fast Fact Card



IFR Systems

IFR Systems designs, manufactures and markets communications service monitors, RF and microwave spectrum analyzers and avionics test equipment. The company also provides test equipment for fiber-optic systems.

Circle (363) on Fast Fact Card

Harger Lightning Protection

Harger Lightning Protection is a manufacturer/supplier of lightning protection/grounding equipment and surge-suppression products. Harger staffs a full-service engineering department to assist in designing lightning protection systems. Free catalog available.

Circle (360) on Fast Fact Card

IDA

IDA is the world leader in the design and manufacture of tone and dc remote controllers. The new Super 99 series allows control and display of as many as 99 channels as well as complete control of many popular trunking radios.

Circle (361) on Fast Fact Card



The Clear Choice

Larsen Electronics

Larsen Electronics manufactures high-performance mobile, on-glass, portable and base station antennas. More than 1,000 antenna models from 27MHz to 2+GHz for international, commercial and amateur applications.

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Circle (366) on Fast Fact Card

Midland Land Mobile Radio

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Circle (367) on Fast Fact Card

OPTOELECTRONICS Optoelectronics

Manufacturer of nearfield test receivers, frequency recorders, frequency counters and tone decoders. These instruments are used extensively in the areas of electronics test, two-way radio, amateur radio and communications monitoring.

Circle (368) on Fast Fact Card

Otto Engineering

Otto's 24dB-rated noise-attenuating headsets feature enhanced cable for greater strength and new speaker elements designed to meet stringent mechanical and thermal shock tests.

Circle (369) on Fast Fact Card

PiRod

PiRod's "Tower Parts and Accessories" catalog is loaded with photos, drawings and descriptions to help you identify, specify and price the tower parts you need.

Circle (370) on Fast Fact Card

RELM Communications

LMC Systems includes RELM repeaters, base stations and duplexers. LMC Components also has a variety of repeater system and antenna site performance enhancement products, such as cavity filters, transmitter combiners, receiver multicouplers, terminations, cable assemblies, IM suppression panels, isolators, circulators and other accessories.

Circle (371) on Fast Fact Card

RITRON, INC.

Ritron

Ritron's low-cost, synthesized repeaters are ideal building blocks for constructing UHF LTR trunking systems. They can be directly interfaced to most trunking controllers and can be driven by amplifiers rated as high as 100W. UHF and VHF models are available (VHF for export only).

Circle (372) on Fast Fact Card

Samlex America

Full-line manufacturer of power conversion products, including linear and switchmode dc power supplies, voltage converters and regulators. Specializing in power supply for the communications industry.

Circle (373) on Fast Fact Card

Circle (376) on Fast Fact Card

TELEWAVE, INC.

Telewave

Introduced at IWCE '96, the Telewave TATC-8945 Auto-tune Trunking Combiner is our latest full-power, rack-mount system solution. Contact Telewave with your system requirements.

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See ads on pages 21, 23

TRANSCRIPT INTERNATIONAL

Transcript International

The DME 9600 dual-mode encryptor provides both digital encryption and analog voice privacy over PSTN. The unit is backward-compatible with our analog cellular and landline voice privacy products and plugs between the handset and base of any office phone, preserving proprietary features.

Circle (376) on Fast Fact Card

Tripp Lite

Tripp Lite's TL series power supplies offer high-quality, 12V, dc output power with attractive low-profile housings designed to accept all popular radios, for an integrated base station appearance.

Circle (377) on Fast Fact Card

VEGA

Vega

Vega's new C-6024 Multiline desktop console can accommodate both dedicated leased circuits and telephone lines. The C-6024 is expandable to 24 lines and comes with a touchscreen display.

Circle (378) on Fast Fact Card

VoCom Products

VoCom Products designs and manufactures RF power amplifiers. It offers amplifiers for the global trunking, paging and two-way radio markets.

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ZETRON INTERNATIONAL

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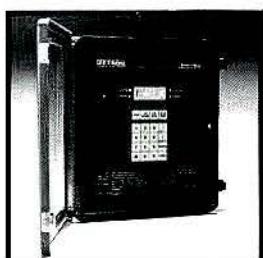
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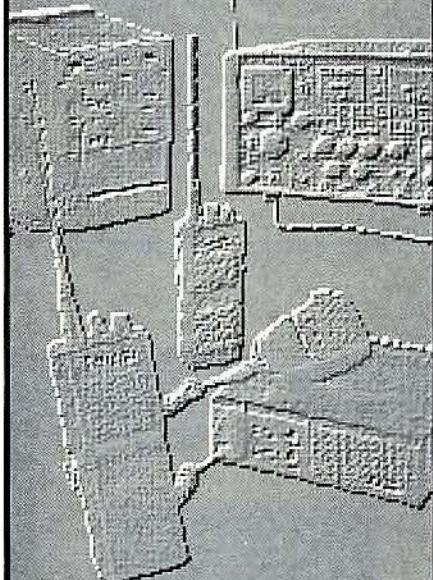
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November 1996 **Mobile Radio Technology** 67

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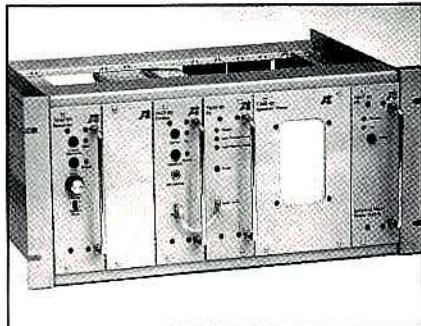
68 Mobile Radio Technology November 1996

New products

Modules can be configured as base stations, repeaters with eight channels

The T800 series modules from **Tait Electronics** can be configured as fixed or portable base stations, in-band or cross-band repeaters, or trunked repeaters. Modules can be mounted in free-standing cabinets, on 19" racks or on panel units. Weatherproof 12Vac battery-powered portable units are also available. The modules can be configured for as many as eight channels (VHF, UHF or 800MHz) and are PC-programmable for as many as 128 DIP switch-selectable frequencies.

Circle (401) on Fast Fact Card



System brings open architecture, flexibility to large radio networks

The Open Digital Integrated Network (ODIN) from **E.F. Johnson** is a communications system designed for open architecture, flexible network topology and smooth migration paths to create large networks for most radio applications. An ODIN-based system is built from modular network components, both hardware and software, that employ industry standards (such as TCP/IP protocols) wherever possible. The components can work independently but can also share system data for services such as wide-area subscriber roaming. An ODIN can operate in analog or digital modes, handling both voice and data, without dependency on frequency or protocol. The APCO Project 25-compliant network technology is compatible with Johnson's Multi-Net

and LTR trunking as well as conventional radio systems.

Circle (402) on Fast Fact Card

Paging transmitter upgrades improve path for migration

Two additions to the paging transmitter offerings of **Glenayre's Wireless Messaging Group** improve on the GL-T8000 transmitter series and provide a migration path to narrowband PCS applications. The GL-T8601 (500W) and GL-T8501 (250W) solid-state transmitters are designed to allow paging carriers to easily migrate their networks to compete in the NPCS market through a straightforward field upgrade to Glenayre's linear transmitters.

Circle (403) on Fast Fact Card

Numeric pager line adds sideview, Flex protocol model with backup



Standard Telecom America has added the first Flex-protocol pager to its product line. The Tutti-X is a sideview, numeric pager with memory

backup, four melody alarm tones and a 16-character, backlit LCD. Features include calendar and clock functions, switchable vibrate/tone alerts, date-and-time message stamping and error message detection.

Circle (404) on Fast Fact Card

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Readers' choice

Of all the new products and services in the April 1996 issue, the one reprinted here generated the most reader requests for additional information. If you missed it the first time, here is your opportunity to acquire more information on it. Just circle the corresponding Fast Fact Card number on the card found in the back of this issue and mail the card to us.

Narrowband receiver fits entirely inside ear canal for covert use



The Microear miniature receiver, available through **Television Equipment Associates**, fits entirely inside

the ear canal. The VHF narrowband, professional military-grade FM receiver has automatic frequency control for optimal reception. Designed for security and public safety tactical applications, the receiver operates in the range of 138MHz-190MHz and contains an automatic squelch circuit and a self-adapting filter to reduce background noise. The maximum effective receiving range is one mile. Battery life is 15 to 30 hours. High or low volume settings may be selected by the user.

Circle (500) on Fast Fact Card

Paging transmitter system allows quick activation to maintain license

License Starter from **Eagle Telecom International** is an expandable, turnkey system that allows paging licensees to activate their systems quickly. The fully synthesized system can be configured with as many as four frequencies in the VHF, UHF or 900MHz bands. Weatherproof construction allows the system to be installed in exte-

nior as well as interior sites. The solid state, continuous-duty amplifier provides 15W (40W optional) of output. The POCSAG-protocol system works with both alphanumeric and numeric pagers at rates of 512bps and 1,200bps. Features include a built-in 31" antenna and telephone interconnect.

Circle (405) on Fast Fact Card

Mounting system offers top plate, extension options for two devices

For the installation of two communications devices using only one mount, **SMC** provides two options. The DMB-2, specifically designed to be used with the SMC 106T pedestal mount, is an aluminum extension that uses thumb-

screw (T-knob) fasteners. The OSTP-3 is a top plate fabricated from heavy-gauge steel and designed to meet the requirements of the Motorola Hands Free Kit.

Circle (406) on Fast Fact Card

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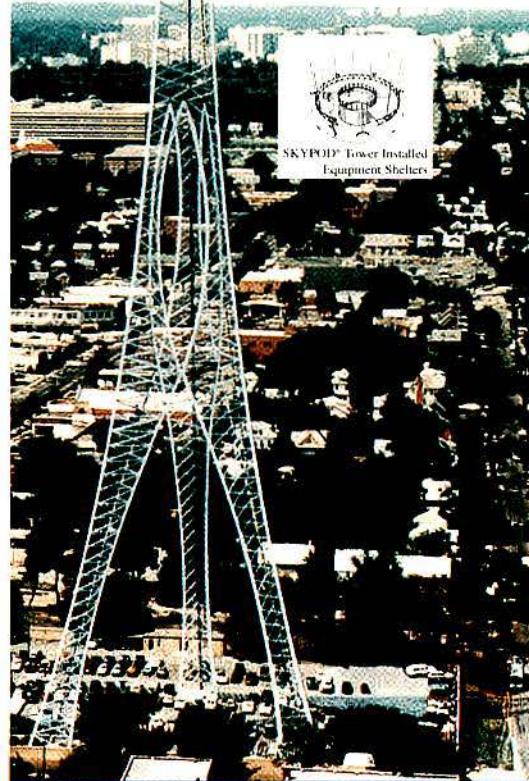
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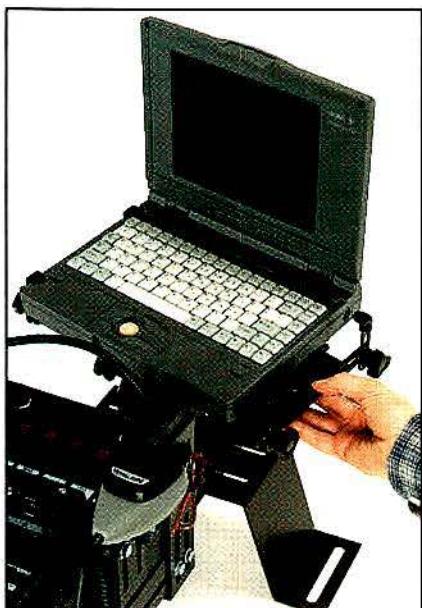
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Circle (65) on Fast Fact Card

New products

Mobile computer mount includes slide tracks for easy installation

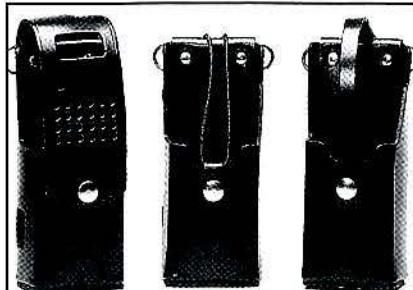


A locking laptop computer mount featuring a quick-release latch is part of the Consolidator series of vehicle consoles and mounts from **Havis Shields Equipment**. The computer mount is one com-

ponent in a series designed to simplify installations by bolting equipment to slide tracks recessed in the top of the base.

Circle (407) on Fast Fact Card

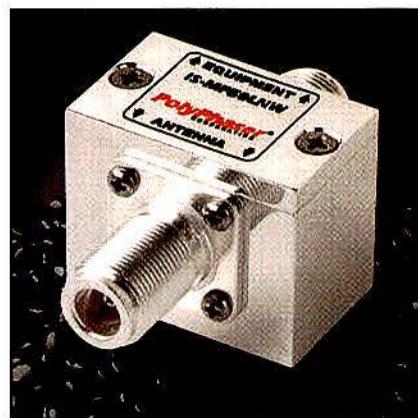
Durable portable radio cases protect more than 300 models



Leathersmith's Dura-Hide carrying cases for protecting portable radios are available in more than 300 models. The cases include nickel-plated hardware, with several swivel options. The cases are designed to withstand harsh environments and to repel most chemicals.

Circle (408) on Fast Fact Card

Lightning protector reduces surge throughput for PCS applications



The Micro Lightning Block Protector from **PolyPhaser** is a single broadband device for 980MHz to 2.6GHz applications, including PCS. The small-footprint protector reduces surge throughput to less than 0.5 microjoules at 3kA. Providing both positive and reverse voltage protection, the unit exhibits insertion of less than 0.1dB and VSWR of less than 1.1:1 over the large bandwidth.

Circle (409) on Fast Fact Card

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Wireless World Expo - Booth #712

Unit employs frequency domain reflectometry to check RF faults



The Site Master III from **Anritsu Wiltron** is a precision analysis tool for measuring SWR, return loss, cable insertion loss, RF power (wattmeter) and distance-to-fault on both analog and digital transmission lines. The unit has a 5MHz to 3,300MHz range and the ability to reject external RF interference. The unit employs frequency domain reflectometry (FDR) for applications including HF, paging, cellular and PCS, allowing it to locate RF faults as well as dc open- or short-circuit conditions.

Circle (410) on Fast Fact Card

Tone encoder upgrade gives direct LED display readout of frequency



Communications Specialists' upgraded version of its TE-64D tone encoder is a multipurpose CTCSS/burst unit that displays the tone frequency on a four-digit LED. The self-contained, fully enclosed encoder provides all EIA CTCSS tones from 67.0Hz to 203.5Hz and all common burst tones from 1,600Hz to 2,550Hz in 50Hz increments. A front dial rotary switch provides tone selection for mobile applications, night operations or other situations requiring high-visibility readout. Frequency accuracy is 0.1Hz for subaudible and 1.0Hz for audible tones. The digital display portion of the TE-64D can be added to an existing TE-64 unit as an upgrade.

Circle (411) on Fast Fact Card

Shared repeater tone panel unit features on-line or off-line programming



The model TP-163 shared repeater tone panel from **Connect Systems (CSI)** is available for 19" rack mounting in either a single or dual configuration. The panel features on-line or off-line programming using CSI's

TP163MGR application program, cross-busy input for LTR overlay and separate DCS and CTCSS level controls. The unit supports 163 users with 51 CTCSS tones and 112 DCS codes. Other features include CTCSS reverse burst and DCS turn-off code for squelch tail elimination, over-the-air DTMF programming and low standby current.

Circle (412) on Fast Fact Card

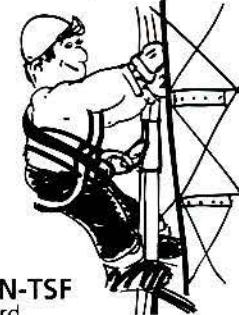
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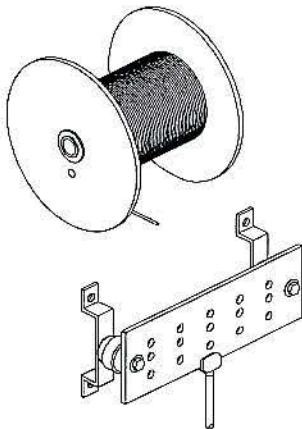
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Circle (67) on Fast Fact Card

New products

Pager line offers levels of feature-intensiveness

The MessageMaker line from **NEC America** is a series of front-display, numeric pagers that provide a range of options, color choices and graphic symbol icons for the LCD. The MessageMaker I unit is designed for first-time pager users. MessageMaker II's more advanced features include a built-in clock with time stamp and alarm, increased message capacity, a variety of alert choices and nine communication icons. The fully featured MessageMaker III has complete numeric message capabilities, including message protection and deletion, expanded message storage capacity and nine icons.



Circle (413) on Fast Fact Card

Accessory program includes products, dealer support



Multiplier Industries has created a full line of American-made cellular and PCS accessories including battery eliminators, vehicle power cords, antennas, mounts, leather cases and conditioning chargers. The Multiplier Plus program includes dynamic packaging, point-of-purchase (POP) displays, inventory management and sales training. Additional products are being developed for TDMA, CDMA, GSM, PCS and wireless data devices.

Circle (414) on Fast Fact Card

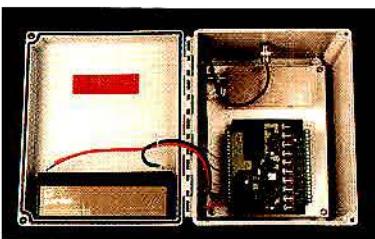
Feedback eliminator digitally records into memory



Racom Products' model 1200FE Digital Feedback Eliminator eliminates paging system feedback by digitally recording a page or announcement from a paging system into memory. The page is played back when the station is deactivated (once or twice, as necessary). The 1200FE has an optional telephone line interface and an alert tone.

Circle (415) on Fast Fact Card

Remote devices, controllers support antenna sites



Midian Electronics' RD1 and RD10 remote devices and RC10, RC100 and CAD1000 remote controllers are Windows-programmable for a variety of applications. User-selectable options include output polarity, input polarity,

alarm reporting and polling. The CAD1000 PC modem controller can control hundreds of remote units and has additional features such as event timers, communications logs for RX and TX traffic, and autodialers. Applications include SCADA and antenna site operations.

Circle (416) on Fast Fact Card

MicroTalk

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Data terminal supports reader, GPS peripherals

The Metro Messenger mobile data terminal and companion Dispatch Manager software from Trident Micro Systems provide an interface to most two-way radios. The terminal has a high-visibility vacuum fluorescent display. Peripherals supported by the terminal include a card reader and a GPS receiver for AVL applications. The software is compatible with Microsoft Windows 95 and includes a user-friendly dispatcher interface. The software features support for messages, multiple message priority levels, fleet status at a glance and mapping software for vehicle location.

Circle (417) on Fast Fact Card



Paging programs extend operator's control to agents

Zetron has combined two programs, EZBASE (easy ZBASE) and SAA (Secured Agent Access), as the Easy Agent Access method for its 2000 series paging terminal's ZBASE data. EZBASE allows a system operator the option of having its agents take over pager control of changes. A system operator's agent can dial in (using any terminal program) and handle the issuing, changing out, turning off or listing of pagers. System operators have full control over which phone number ranges, or even which individual records, an agent may access, and what actions are allowed. The system operator may restrict the maximum number of records agents may have, the fields the agents may alter or view, and even the field values the agents are allowed to use. Both the system's own operators and its agents can actively use ZBASE at the same time.

Circle (418) on Fast Fact Card

Emulator duo tests noise, fading for CDMA systems

The TAS 4600 Noise and Interference Emulator (upper unit) and the TAS 4500 FLEX4 RF Channel Emulator (lower unit) combine as a complete package for CDMA test applications. The units from Telecom Analysis Systems (TAS) are used to test a wide range of communications devices, including base stations, modems, cellular phones, wireless local loop and personal communication devices. The two-channel noise emulator performs noise, carrier-to-noise and carrier-to-interference tests. The Flex channel emulator enables users to select fading models and fading sequence length.

Circle (419) on Fast Fact Card



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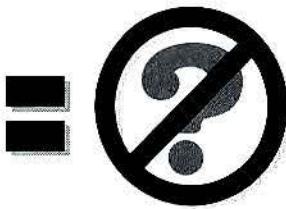
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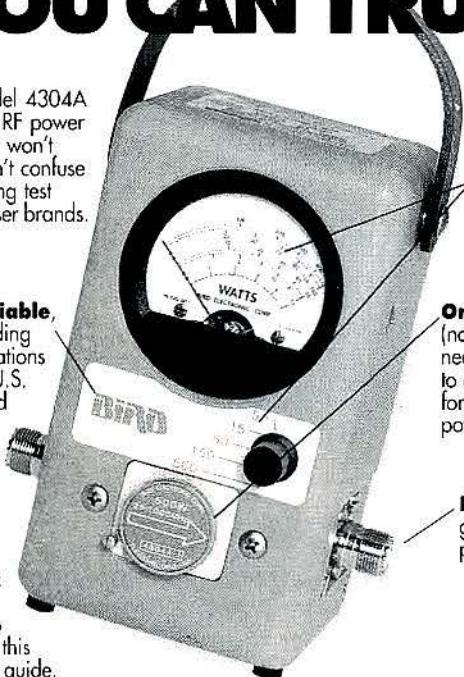
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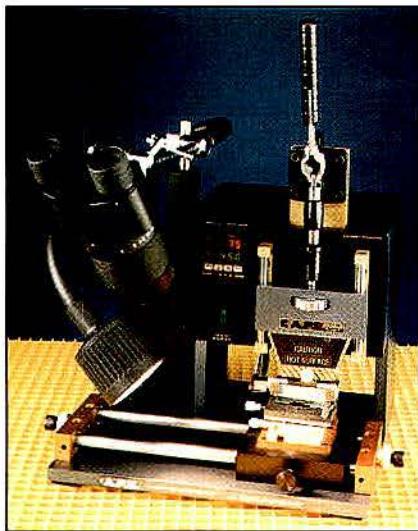
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Circle (69) on Fast Fact Card

New products

Repair system provides accurate pressure bonding

The BondMaster, from **Automated Production Equipment**, is a pressure-bonding repair system for heat-sealed connectors and mylar flex circuits. The system aligns the radio, pager or other type of display array and its interfacing board via a universal fixture that enables the two parts to be positioned under a temperature-controlled bonding head. Factory-programmed and stored measurement profile groups are available for all current Motorola pager and radio products. Temperature ramping is preprogrammed to prevent thermal stress, and a time informs the user when the process is complete. The system is available in both 110V and 220V versions.

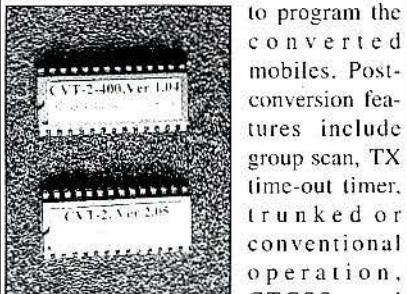


Circle (420) on Fast Fact Card

MT

EEPROMs Provide Trunking Conversion for Mobiles

IDA Corporation of Fargo, ND announces the availability of LTR trunking conversion EEPROMs for various Motorola and Motorola Radius mobile radios. The replacement EEPROMs are available for popular models in the 400 MHz, 800MHz and 900MHz bands. LTR conversion of Privacy Plus mobile phones is also being offered. An inexpensive programming kit is required



to program the converted mobiles. Post-conversion features include group scan, TX time-out timer, trunked or conventional operation, CTCSS and

CDCSS, block decode and automatic channel acquisition.

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Circle (68) on Fast Fact Card

Paul D. Edelhertz leaves Andersen Consulting, Seattle, as associate partner to join Racotek, Minneapolis, as vice president of customer solutions.

Changes at Hutton Communications, Dallas:

Luis M. Larralde departs International Jensen, Lincolnshire, IL, as international sales manager to join Hutton as international area manager. He will work out of Hutton's Miami office.

Chris J. Ryg leaves Communications Associates, Joliet, IL, as vice president and general manager to join Hutton as corporate vice president and director of marketing.

Changes at Alltel Mobile Communications, Little Rock, AR:

Chris Smith, general manager of the Missouri cellular operations based in Springfield, MO, becomes general manager for the North Carolina cellular system based in Charlotte, NC.

Leo Perreault, retail operations manager of cellular operations in Little Rock, AR, becomes general manager of the Missouri cellular system based in Springfield.

Paul Bowersock, business processes manager, becomes general manager for the southwest Georgia cellular system based in Albany, GA.

Mitch Johnson, administrative operations manager in Little Rock, becomes general manager for the western Arkansas market.

Lawrence Corvari exits Network Designs, Redmond, WA, as president to become vice president of engineering for XYPoint, Seattle.

Gerald R. Hoffman, vice president of finance for Hawker Energy, Warrensburg, MO, advances to general manager and executive vice president.

Changes at Comsat Mobile Communications, Bethesda, MD:

Alan Labbe retires from the U.S. Navy as program manager, Inmarsat programs, to join Comsat Mobile as manager, government maritime accounts.

Robert Roe leaves C-Cubed, Alexandria, VA, as director, business development to join Comsat Mobile as manager, Navy account.

Michael Smith leaves Bell Atlantic Nynex Mobile Communications, Tampa, as lead government sales account manager to join Comsat Mobile as manager, Department of Defense land mobile government sales.

Craig Poyner leaves the government aeronautical applications and installations department of Racal Satcom, Silver Spring, MD, as government sales representative, to join Comsat Mobile as national manager, aeronautical sales.

Changes at PageMart Wireless, Dallas:

N. Ross Buckenham departs Touchtone Solutions, San Francisco, as president to join PageMart as vice president and general manager of PCS. He will divide his time between the Dallas and Hayward, CA, offices.

Wayne Stargardt exits Pinpoint Communications, Dallas, as vice president of marketing to join PageMart as vice president of PCS business development. He will be located in Dallas.



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Circle (82) on Fast Fact Card

CD ROM reference work addresses battery maintenance and testing

"Marco Migliaro's Pictorial Reference of Stationary Battery Maintenance and Testing" is a reference work available on CD ROM from **The Battery Connector**. The CD ROM contains more than 40 subject areas related to lead-acid and nickel-cadmium stationary battery problems, inspections, test-

ing and corrective actions. The reference work is targeted to persons involved in the inspection, maintenance and testing of stationary batteries anywhere in the world. Included in the CD ROM are more than 300 color photographs with supporting text and a glossary with more than 300 terms.

Circle (301) on Fast Fact Card

Communications equipment catalog includes training information

Trident Micro Systems' 41-page catalog covers the full line of products that are available from the company. A variety of equipment, cables, connectors and accessories are showcased, and the catalog includes controllers, call rout-

ers, voice mailbox, loggers, monitors, modems, multiplexers and cable assemblies. Manuals and software are listed at the back of the catalog, and shipping, warranty and training information is at the front.

Circle (302) on Fast Fact Card

Mounting equipment guide showcases modular systems, locking systems

The 27-page "Guide to Mobile Mounting Equipment" from **Scientific Dimensions** features console, pedestal and slide mounts. The company also manufactures electronic computer docking stations that

offer port replications, power conversion and service for the utility environment. The company is able to manufacture from custom specifications and can modify current products to meet customers' needs.

Circle (303) on Fast Fact Card

Catalog lists coax connectors, related assemblies and kits

The 100-page catalog from **RF Connectors**, a division of RF Industries, features a range of coaxial connectors, including 300 new items. BNC, TNC, N, UHF, Mini-UHF, MB, SMB and SMA are some of the connectors covered in the catalog. More than 1,500 coax products are also included, such as cable assemblies, connector kits, cellular products and hand tools. Product specifications and photographs are available in the catalog.

Circle (304) on Fast Fact Card

Data sheet provides information on channel sounder for PCS testing

The four-page data sheet from **Berkeley Varitronics Systems** provides technical information on the Duet channel sounder for practical propagation analysis of TDMA, FDMA or CDMA formats in the PCS band. Actual captured multipath screens describe the digitally modulated signals at PCS frequencies.

Circle (305) on Fast Fact Card

Set Sail for San Diego

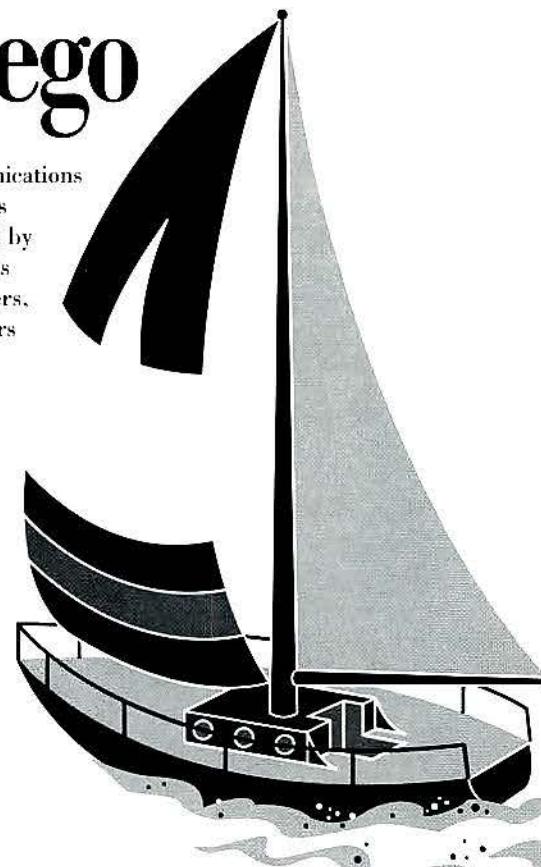
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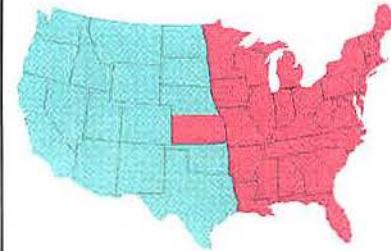
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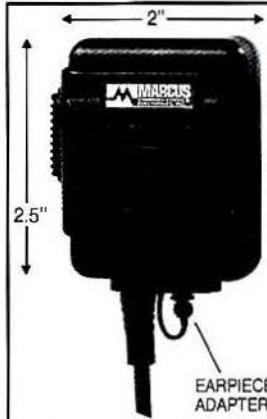


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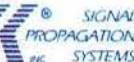
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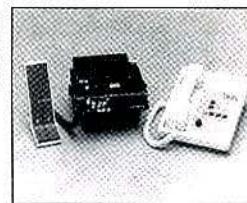
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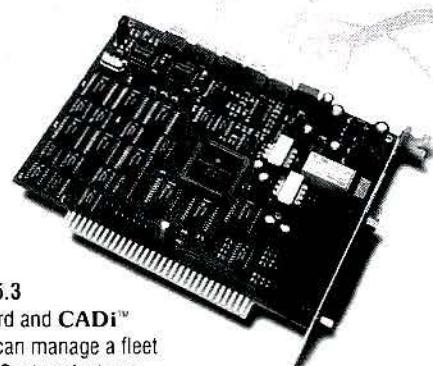
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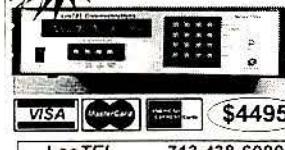


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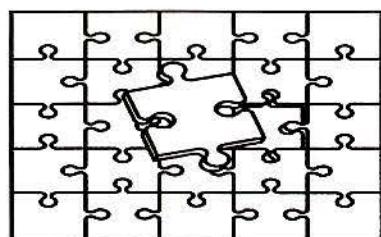
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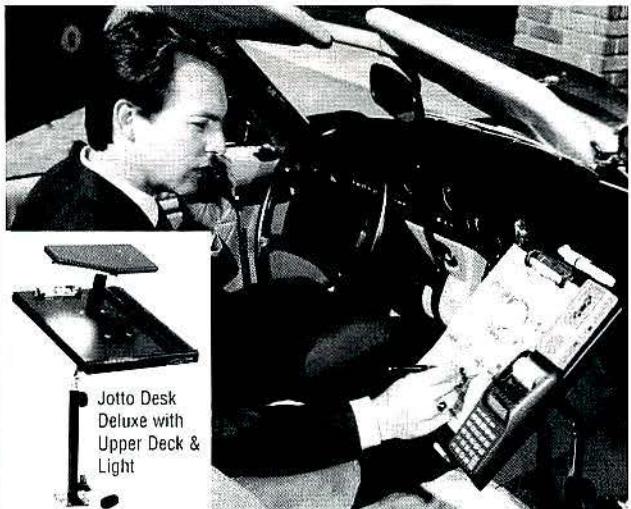


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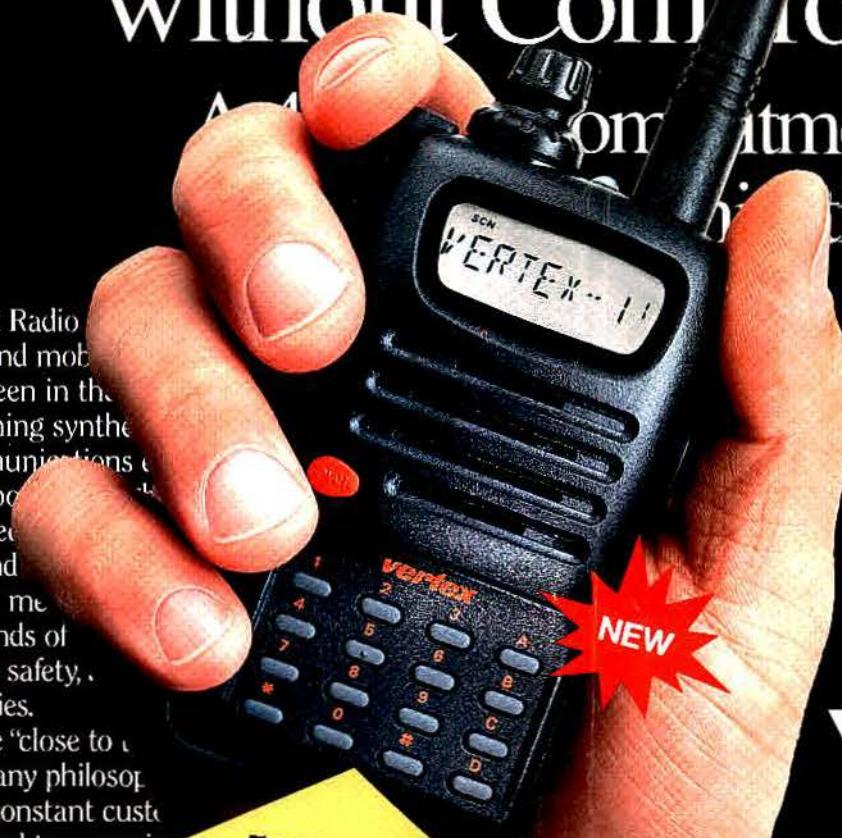
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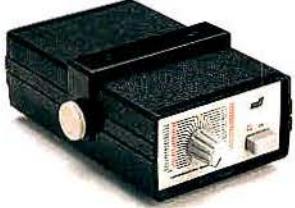
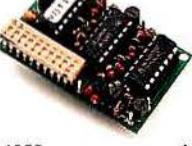
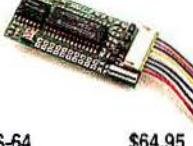
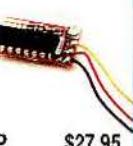
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